UNIVERSITY OF SOUTHAMPTON

FACULTY OF HUMANITIES

Archaeology

Is There a Regional Variability Within Clovis Fluted Points in North America Influenced by Raw Material Selection?

An Analysis of Basal Concavity Shape

by

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Thesis for the Degree of Master of Philosophy

Submitted 30th November 2018

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ABSTRACT

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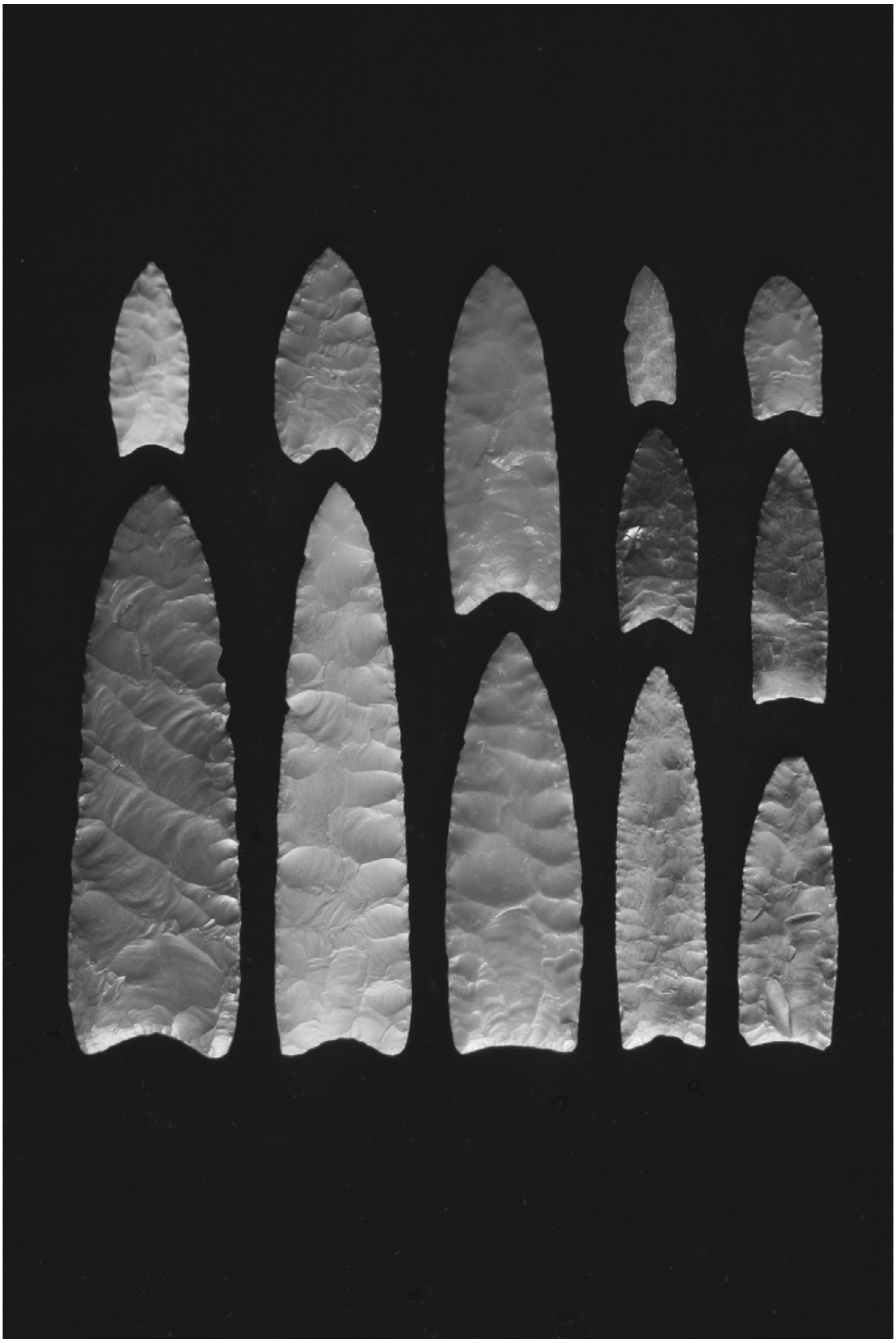
IS THERE A REGIONAL VARIABILITY WITHIN CLOVIS FLUTED POINTS IN NORTH AMERICA INFLUENCED BY RAW MATERIAL SELECTION?

AN ANALYSIS OF BASAL CONCAVITY SHAPE

By Alan M. Slade

At some time around the end of the last ice age, around 11,500 ^{14}C yr BP / 13,300 Cal yrs BP, the first human hunter-gatherer groups entered North America where they encountered diverse environments and climates. These groups once separate and exploring these landscapes in a vast continent were hunting and killing the same megafauna; perhaps for the first time, they would have encountered mammoth, mastodon, gomphothere, giant sloth and camel etc. Other smaller, more recognisable species were also present and hunted; elk, deer and caribou and bison for example. Clovis fluted points were long regarded as the hallmark of the first humans to occupy the Americas. The different environments and landscapes encountered by these separate groups may account for the extent of the variability of these points that are so characteristic of this period. In this thesis research I suggest that Clovis was not the first stone tool technology in North America and that fluted points evolved from an earlier technology, and that Clovis was a localised fluted form that evolved regionally as these first groups spread out across the continent.

In a previous study I asked the question "what is Clovis", perhaps after the present study "what is not Clovis" may be more appropriate.



A selection of cast replicas of Clovis fluted points from various well-documented sites in North America. After Waters and Stafford (2007). Image reprinted courtesy of M.R. Waters

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Expectations and outcomes taken from my literature review in Chapter 2, analysis and lithic raw material sourcing and movement patterns from Chapter 4, and results of the caliper-based metric and geometric morphometric (GM) and principal component analysis (PCA) tests in Chapter 5

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Academic Thesis: Declaration Of Authorship

I, ...Alan M. Slade....................................[please print name]

declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

[title of thesis] ... **Is There a Regional Variability Within Clovis Fluted Points in North America Influenced by Raw Material Selection?** ....

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University;
2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
3. Where I have consulted the published work of others, this is always clearly attributed;
4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
5. I have acknowledged all main sources of help;
6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
7. Either none of this work has been published before submission, or parts of this work have been published as: [please list references below]:

Signed: ....

Date: ....November 2018........................

Declaration

Although based on a previous study (Slade 2010), this thesis is an original piece of work which looks at the variability of Clovis fluted points in North America on a continental scale through basal morphology and raw material variability. None of the material contained in this thesis has previously been submitted for a degree at the University of Southampton.

Statement of Copyright

Acknowledgements

Grateful thanks are due to everyone who has helped me throughout my studies, but most of all to John McNabb, for his patience, support, encouragement, and ongoing tolerance. I am also extremely grateful to Clive Gamble, Tony Baker, Metin Eren, Christian Hoggard, Nick Ashton, Craig Williams and Ian Taylor for all their help, support, encouragement, and guidance over many years. Special thanks goes to Dennis Stanford who gave external academic advice, support, encouragement, and for his generosity in sharing his research. This research would not have been possible without the access I was given to the collections of Clovis fluted points from the Smithsonian Institution in Washington DC, the Arizona State Museum (ASM) in Tucson Arizona, and the Denver Museum of Natural History and Science (DMNH) in Denver Colorado. Thanks to Candace Sall from the Museum of Anthropology, University of Missouri in Columbia Missouri for her generous cooperation with Clovis replica casts and access to the photographic database and archive. Personal collections of Tony Baker in Denver Colorado and Carl Yahnig in Christian County Kentucky. For this access I am indebted to Dennis Stanford and Mike Frank (Smithsonian), Vance Haynes Jr., and Vance Holliday (ASM), and to Steven Holen (DMNH). And numerous other members of staff and support staff from these institutions. To friends and colleagues who also helped this thesis take shape through their insights, comments discussions and general assistance, I thank you all. I would also like to express my thanks to Dr John McNabb, Prof Dennis Stanford, Prof Clive Gamble, Dr Metin Eren, Dr Leland Bement, Prof Michael Collins, Dr Juliet Morrow, Dr David Meltzer, Dr Andrew Hemmings, Dr George Crawford, Dr Kenneth Tankersley, Dr Philippe LeTourneau, Dr Mike Gramly, and Mike Kunz for access to personal research and unpublished material. My gratitude for their advice, support and encouragement during writing this thesis and to all the others who have helped through their valued comments on earlier drafts and chapters especially Dr Christian Hoggard and Dr Kristen Heasley at the University of Southampton. Thanks are also due to Chantal Geall, Peter Hoare, and Nick Ashton for their generous efforts in proof reading and comments on earlier drafts.

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Many thanks for all the friends and colleagues who generously put me up on my travels to North America, especially to Paul and Jodie Rawson, Tony and Simone Baker, Carl and Polly Yahnig, To Tony Baker who introduced me to North American archaeology and in the 10 short years I was privileged to know him he became a true friend. To Metin Eren who whilst he was living here in the U.K. generously invited me into his home and shared his knowledge of lithic reproduction and knapping techniques with me.

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Thank you all

(I apologise if I have forgotten anyone, you know who you are and I thank you sincerely)

To Ele "Tony" Antoine Baker

1944-2012

Chapter 1

Introduction

1.1 Clovis: an investigation into an early Paleoindian culture

Clovis is widely regarded as the oldest archaeologically visible, reasonably well-defined, and relatively homogenous early archaeological culture in North America. Clovis also has the most geographically extensive signal in the archaeological record of North America at any time (Miller *et al.* 2013). It has been reported as being present in all forty-eight states in inland North America, as well as in some areas of sub-glaciated Canada, Mexico and South America (*e.g.* Haynes 1964; Haynes 2002; Meltzer 2009; Anderson *et al* 2010). Our understanding of the first humans in North America has greatly improved over the last couple of decades (see Meltzer 2003a, 2009; Pitblado 2011; Davidson 2013; Shott 2013; Kornfeld and Politis 2014; Erlandson and Braje 2015; Lothrop *et al.* 2016; Amick 2017; Sutton 2017), and understanding Clovis origins and variability is critical in this understanding (*e.g.* Wright 1989; Bonnichsen 1991; Meltzer 1993, 2003, 2009, 2013; Haynes 2002, 2015; Tankersley 2004; Stanford *et al.* 2006; Miller *et al.* 2013; Buchanan *et al*, 2017; O'Brien and Buchanan 2017).

Several definitions of Clovis have previously been offered. To some, Clovis is a time period (*e.g.* Haynes 2002). To others, Clovis is a culture (*e.g.* Haynes 2005). And for others still, Clovis is a techno-complex (*e.g.* Bradley *et al.* 2010). For the purpose of this thesis it will be defined as a time period and the terms Clovis-era, and Clovis-age will be used for consistency. It has been suggested that Clovis represents a major culture change, spreading out among existing pre-Clovis populations (Bradley and Collins 2013; Collins *et al.* 2013), whilst others suggest these models are weakened by the limited quality of secure pre-Clovis evidence (Shott 2013; Haynes 2015). It is my opinion that while I do believe in a pre-Clovis presence, Clovis is considered to be the first universal lithic technology to evolve in North America, occurring between 11,500 and 10,900 radiocarbon years before present (^{14}C yr BP), 13,300 to 12,700 calibrated calendar years (Cal yr BP) [1]. (Hamilton and Buchanan 2007). A re-evaluation of the available date record, and more accurate and precise ^{14}C yr dates taken from Clovis sites with technologically diagnostic artefacts place the Clovis time range from around 11,050 to 10,800 ^{14}C yr BP. Although there are additional sites with Clovis artefacts with dates outside these ranges, they have large standard deviations. This re-evaluation of the existing Clovis date record places the time range to as little as 200 years (Waters and Stafford 2007, 2013).

These early hunter-gatherers left behind a sparse material record of their occupation that consists primarily of stone tools and the manufacturing debris associated with their production. The trademark tool of this earliest lithic technology to evolve in North America is a fluted point named after its type site discovery in a quarry at Blackwater Draw Locality No. 1 (LA3324), near Clovis, a town in New Mexico (Hester 1972). These artefacts were made by widely separated groups at almost the same time throughout North America. The fluted points from Nova Scotia are much the same as those from New Mexico, not identical, but the similarities outweigh the differences. Not only are the fluted points similar across North America, but other technological aspects of the Clovis culture, i.e. blades, unifacial tools, and osseous tools, appear to be equally similar and widespread (Haynes 1964). The differences that are present are in the styles and shape of the Clovis points. In this study I identified a number of Clovis and Clovis variants from seven environmentally very different regions across North America (Figure. 1.1), which I will discuss in more detail in Chapter 2. The regions I incorporated are based on modern political boundaries and follow current U.S State

[1] for the purpose of this study I will, where possible, use ^{14}C yr BP dates, and when appropriate I will provide the Cal yr version as well. If the ^{14}C yr date is not available, the Cal yr date will be provided (see Table. E.1 in appendices). The distinction between radiocarbon years and calendar years is important. A report in 2000 (Johnson *et al.* 2000) described a 13,000 year-old human skeleton found in California and compared it to a 12,500 year-old from Monte Verde, without mentioning that the former was calendar years

borders, they do however correspond to previous continental overviews of Clovis distribution (*e.g.* Haynes 2002:36).

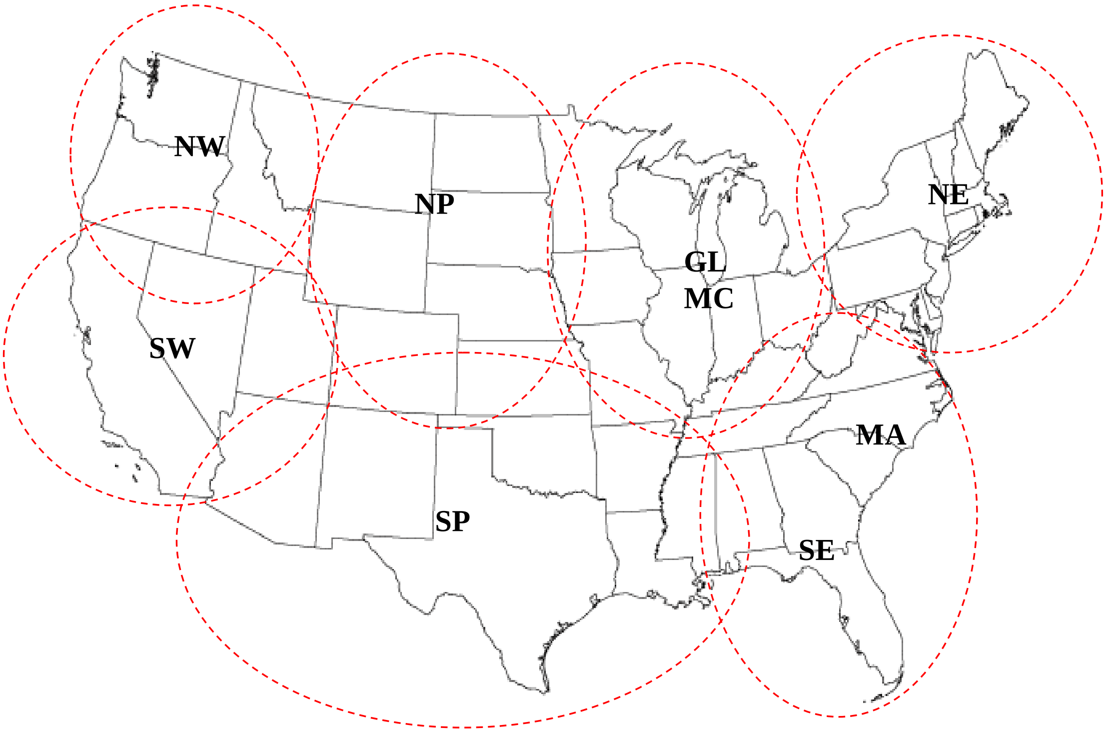


Figure. 1.1 Map of North America highlighting the seven regions including their subregions that I identify in Chapter 2. (NE = Northeast; MA = Middle-Atlantic; SE = Southeast; GL = Great Lakes; MC = Midcontinent; NP = Northern Plains; SP = Southern Plains; NW = Northwest; SW = Southwest and Great Basin

Clovis fluted points have been found in all lower forty-eight North American states (Anderson 1990a, 2013a; Haynes 2002; Anderson *et al.* 2005). It is uncertain whether they are in Alaska as the earliest archaeological evidence there is not Clovis (but see Humphrey 1966; Goebel *et al.* 2013). There is a blade and unfluted thick-bodied point technology present that has been dated to as early as 11,800 ^{14}C yr BP in the Tanana river valley, Alaska (Hamilton and Goebel 1999) known as the Nenana Culture (West 1996). Clovis points are present in some southern unglaciated regions of Canada (Kehoe 1966; Deller and Ellis 1988), and Clovis can also be found in Mexico (Robiles and Taylor 1972; Sánchez 2001), Central America and northern South America (Cooke 1998; Ranere and López 2007). These will not be discussed further here as this particular study is concerned with Clovis points in North America.

Two primary technologies dominated Clovis stone tool flaking, bifacial and blade (Collins 1999a). Bifacial flaking was used to produce the large flake blanks or preforms on which fluted points were produced (Figure. 1.2), and it is these points that will be the main focus of this research. The other technology produced long regular pieces, known as blades, which were shaped into various tool forms such as scrapers, burins, gravers and other small unifacial tools.

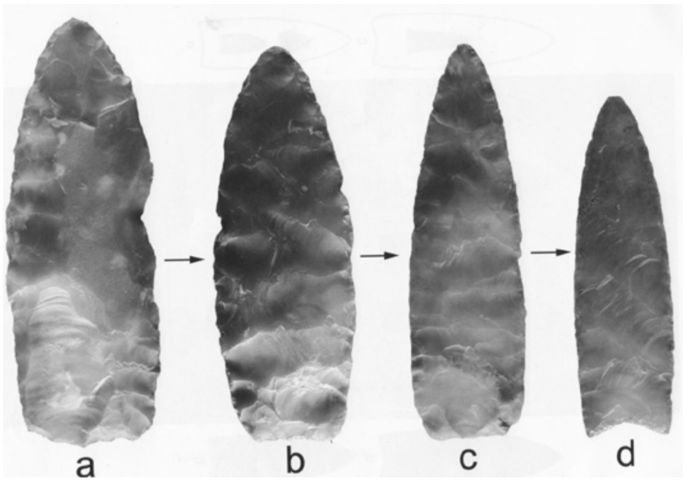


Figure. 1.2 Clovis point production stages. a) early, b) middle, c) late, d) finished point. After Bradley et al (2010)

Previous studies of Clovis fluted points have regularly revealed morphological variation, including my own previous research (Slade 2010). Raw material has been considered to play a role within other early Paleoindian fluted point types (Tankersley 1994a), such as Folsom (Hofman 1991) and Gainey (Morrow and Morrow 2002a) and in individual Clovis site assemblages, but it has seldom been looked at comprehensively on a continental perspective and in particular just on Clovis or Clovis-aged point assemblages (Miller *et al.* 2013; Buchanan *et al.* 2014).

At the Plains Anthropological Conference (PAC) in October 2011 in Tucson, Arizona, a session on Clovis made it clear that there was a need for Clovis, and in particular Clovis fluted point variability, to be properly defined. This was summed up by D. Meltzer at the conference who said that *"until we as archaeologists and analysts agree on what is and what is not Clovis, there will always be this problem in definition."* (D. Meltzer pers. comm. Tucson PAC 2011). The issue is that some researchers define some assemblages of fluted points as Clovis, while others assign them to a different culture, despite being chronologically contemporaneous and technologically similar. Meltzer concluded that he *"would like to see Clovis fluted points defined by style"* (D. Meltzer pers. comm. Tucson PAC 2011).

The majority of the shape variation in Clovis fluted points is displayed in the basal sections of the points, and it is the basal variability of the Clovis points that I based my analysis on. Bases are rarely re-sharpened (Ahler and Geib 2000) and therefore re-sharpening is an unlikely cause for regional and subregional variation in Clovis point variability (see Buchanan *et al.* 2015). However, raw material variability is a possible explanation for point shape variation (Tankersley 1994a; but also see Eren *et al.* 2014b), high-quality toolstone being easier to knap than lower-quality materials. As part of my study, I will also look at whether raw material variability and quality are influencing Clovis point variability.

1.2 Aims and objectives

This study will be an investigation on the basal variability within an early North American Paleoindian fluted point technology, to explore whether different regions of North America have a distinct variation in shape in the basal concavity on Clovis fluted points, and to see whether raw material selection can be a possible explanation for the variability. The aims and objectives for this study are threefold:-

- identify and characterise the range of morphological variation in the bases of the points
- determine whether there a relationship between lithic raw material and the patterns seen in the basal technology
- investigate just how homogenous Clovis really is

Through these objectives I hope to give explanation to how this research will contribute to wider questions, such as the potential implications for regional settlement, landscape-use practices, and technological decision making.

From the visual and metric analysis I carried out for my Masters dissertation (Slade 2010), I observed that there is certainly a distinctive variation in basal concavity shape within assemblages of Clovis points from sites in different regions across North America. The variation seems to be more pronounced when there is significant variation of raw material present in the assemblage, such as at a campsite that has been frequented by different groups coming from different directions and regions. Site types across North America differ by region and an examination of the basal concavity variability, raw material present, and how theses relate to the Clovis sites will be discussed in later chapters, and will also be made available as supporting information (Appendix. A). For determinations of the identification and quality of the raw materials that were used to produce the Clovis points in my analysis, I used published accounts (*e.g.* Buchannan *et al.* 2014) that gave a comprehensive overview of the toolstone types for the points discussed. I also used the individual raw material analyses that were present in the published archaeological record of certain individual assemblages.

1.3 Outline of research

This chapter has outlined the importance of research into the early Paleoindian Clovis culture of North America, how studying the variability of Clovis and Clovis-aged fluted points is of central importance to exploring and understanding early human behaviour in North America, and the key aims and objectives of this thesis. Subsequent chapters will address these objectives in more detail.

Chapter 2 starts with a discussion of the archaeology of Clovis fluted points across the continent and will highlight the variation in these points. This will be followed by a literature review of the history of the research of the topic and offer an appraisal of the current state of knowledge of Clovis and the peopling of North America. Since the first discoveries in the early 1900s, fluted points have been classified as Clovis simply because they were fluted and were associated with mammoth remains or other extinct megafauna of Clovis age (but see Henrikson *et al.* 2017). I will provide the most recent and reliable radiocarbon dates, where possible, for the sites and assemblages that I used in my overview of Clovis fluted points and their distribution that made up my sample. Chapter 2 also deals with the regional distribution of Clovis based on my regional boundaries (Figure. 1.1), and in a comprehensive overview, I provide a regional analysis of the well-known Clovis fluted point record and offer a brief description of the site or collection history, the assemblage itself, and the most recent research of that particular material. I finish off Chapter 2 with a brief description of Clovis site types that occur across North America.

In Chapter 3 I discuss my methodology and approaches to the analysis of the bases of the fluted points that make up my complete sample and present the datasets. My data collection strategies and analysis of the Clovis fluted points used during my Masters research (Slade 2010, 2012) were employed for this research. This will be built upon by carrying out a metric analysis on complete points and photographic imagery, but with more emphasis on the morphological characteristics of the basal concavity and raw material types. Since my original study, I have continued to research the collections of Clovis fluted points in museums in North America, London, Oxford and Paris, as well as accessing private collections in North America. A full record of the collections and locations that made up my complete sample will be also be provided in the appendices (Appendix. B).

Chapter 4 will be based on an overview, previous research and current understanding of the raw material availability and variability that was accessible as potential toolstone for Clovis fluted point production across the North America during the Clovis times. The prehistoric knappers who produced Clovis fluted points used a wide range of raw material available to them, and in some cases this revealed extreme long distance transport of toolstone between the find spot of the point and the geological source of the material (see Gramly 1988a; Holen 2004; Boulanger *et al.* 2015). Either Clovis hunter-gatherers had access to toolstone sources, for example a favoured outcrop of raw material or quarry close to their camps, or they would have traded raw material with other groups, either with other raw material or trade goods. I will compose a distribution map for each region of raw material types and their sources which when compared to fluted point locations would reveal how far the raw material or fluted point travelled (Figures. 4.1 to 4.7). Analysis of the raw material was made from the points themselves where possible, site reports and published accounts, and regional topographical records which were available from the United States Geological Survey (USGS) for each respective state (Table. 4.2).

Chapter 5 will be a review of my caliper measurement based shape analysis and the geometric morphometric analysis of the complete sample of Clovis points that make up my datasets for this thesis. As with previous chapters, this chapter will be broken up into regional sections, and the three samples that make up my complete sample will be presented regionally. The assemblages of points will be compared on a regional and on an intraregional basis. The results of the analysis will then be collated and the variability of Clovis points on a continent-wide perspective using the basal-concavity results and the raw material analysis presented.

In Chapter 6, in accordance with my original research questions, I will present the conclusions which can be drawn from the analyses for understanding the variability of Clovis points both within a regional and continental context. Specific issues were discussed and defined through the evidence for basal concavity variability and toolstone selection. And how all these results can be implemented into our understanding of Clovis as an early Paleoindian North American culture. And finally I will discuss how future research, and my results from this study, can be advanced and refined further through future projects.

Chapter 2

Clovis: type description, dating, regional distribution, and site types

2.1 The archaeological record

North American Paleoindian archaeology has seen a challenge in the last two decades to traditional views on how, when, and from where the earliest hunter-gatherer groups first began to occupy the New World (*e.g.* Adovasio and Page 2002; Bradley and Stamford 2004; Stanford and Bradley 2012; Meltzer 2013, see also Haynes *et al.* 2007; Slade in press b). New archaeological discoveries, re-dating of existing material and new environmental reconstructions (*e.g.* Dyke *et al.* 2002; Waters and Stafford 2007; Bradley *et al.* 2010) have intensified the debate. Clovis was not the first archaeological 'culture' to arrive in the Americas (Madsen 2015) and the issue of Clovis' origins is currently the focus of intense investigation (*e.g.* Bradley and Collins 2013; Graf *et al.* 2013; Madsen 2015; Amick 2016) and fundamental to this is having an understanding of Clovis stone tool technology and usage.

Clovis groups developed a distinctive lithic, bone, and ivory tool technology that spread throughout North America stretching down through Central America reaching northern South America during the end of the last Ice Age ~11,500 ^{14}C yr BP / ~ 13,000 Cal yr BP (*e.g.* Haynes 2005; Waters and Stafford 2007, 2013; but also see Haynes *et al.* 2007; Madsen 2015; Eren and Buchanan 2016; Amick 2017). Clovis fluted points, have been recovered from a range of Clovis sites, from single kill sites of now extinct Pleistocene megafauna such as mammoth (Haury *et al.* 1959), to large occupation campsites that suggest long-term use of a particular location (Collins 2002).

Fluted points that are now recognised as being Clovis have been found in association with extinct megafauna and have been reported since the early 1900s (see Marshall 2001; Haynes 2002), but it is only since 1941 that 'Clovis' has been formally recognised as a distinct archaeological culture in North America (Hurst 1943; Wormington 1944). The characteristic Clovis fluted point (Figure. 2.1.) has been the primary, and in some cases, only marker for identifying an assemblage being Clovis, especially when just isolated points are discovered or when a kill site has little or nothing other than the fluted points present (Haury 1953; Leonhardy 1966).

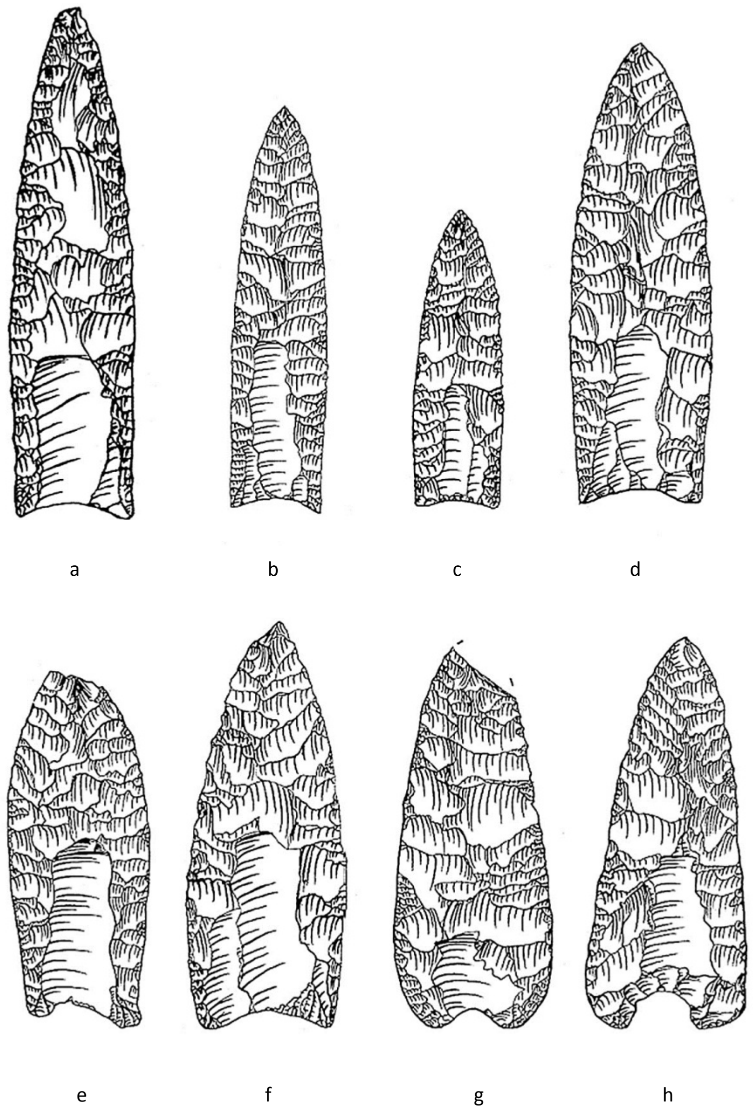


Figure. 2.1 The Clovis fluted point form: examples of shape variation within these points. a-b) Blackwater Draw, NM; c) Domebo, OK; d) Lehner, AZ; e) Murray Springs, AZ; f) Dent, CO; g-h) Colby, WY. Modified from Haynes (2002)

For this study a comprehensive literature review of the previous research was undertaken. Through this review it became apparent that until very recently (Miller *et al.* 2013; Buchanan *et al.* 2014) little or no successful attempt was made to address the question of Clovis point variation on a continental perspective. Indeed many of my peers, some who did attempt such a project themselves, felt it was very ambitious to take on research of this magnitude due to the geographical range and regional distribution of the point types (D. Meltzer pers. comm. Tucson PAC 2011; D. Stanford pers. comm. Smithsonian Institution, Washington DC 2012; L. Bement pers. comm. Norman PAC 2009; and M. Collins pers. comm. Austin SAA 2014).

Fluted points had been discovered previously at Dent, Colorado (Figgins 1933) in 1932 and from the Miami site in Texas (Sellards 1938) in 1934, but were termed as Folsom or Folsom-like by E. H. Sellards of the University of Texas, as Clovis had not yet been classified as a separate technology. In 1936 two fluted points discovered in the remains of mammoth were termed the Clovis site type-specimens [2] I 36-19-2 (BWD 01) [3] and II 36-19-3 (BWD 02) by J. L. Cotter (Cotter 1937). H. M. Wormington made the first documented type description for Clovis (Wormington 1957:63) based on these discoveries. After more excavations and further points were found at the Blackwater Draw site, two separate categories of Clovis points were suggested as the points fell into two distinct forms. J. J. Hester classified the Classic type (Figure. 2.1) illustrated by Wormington, as 'Clovis Type 1', and the much smaller triangular forms as 'Clovis Type 2' (Hester 1972:97). C. D. Howard provided a comprehensive overview of Clovis point characteristics and type descriptions (Howard 1990) and noted that there was a difficulty of identification and comparison of Clovis fluted points and the need for a detailed type description for Clovis.

[2] The two points found in 1936 became the Type Specimens for Clovis after Wormington made the classification (Wormington 1957). These should not be confused with the two Clovis variants that Hester termed Clovis Type 1 and Clovis Type 2, that were based on point size and morphology (Hester 1972)

[3] All specimen numbers and catalogue numbers of Clovis points will be given a unique identifier that corresponds to my database entry (Appendix. C)

More recently there has been considerably more research into early Paleoindian fluted point variability that has focused on Clovis (Buchanan *et al.* 2014). Most of the well-known Clovis sites and fluted point assemblages have been published which contributed to constructing a comprehensive record of Clovis points for this research (Table. 2.1).

LOCATION	SITE TYPE	REGION	CLOVIS ASSOCIATION	PRIMARY SOURCE
Clovis and Clovis-aged fluted points associated with extinct Pleistocene fauna (see Table. 2.5)				
Blackwater Draw, Roosevelt County, NM[1]	Kill / Camp - mammoth & bison	Desert Southwest	Clovis points and other lithics, including a blade cache. The Clovis type-site	Hester (1972) Boldurian and Cotter (1999) Haynes and Warnica (2012)
Colby, (48WA322), Washakie County, WY	Kill - mammoth	Northern Plains	Clovis point variant and other lithics	Frison and Todd (1986)
Dent, (5WL269), Weld County, CO	Kill - mammoth	Northern Plains	Clovis points, reworked point into a hafted knife, first man/mammoth association in N America	Figgins (1933) Brunswig (2007)
Domebo, (34CD50), Caddo County, OK	Kill - mammoth	Southern Plains	Clovis points and other lithics	Leonhardy (1966)
El Fin del Mundo, Sonora Desert, MEX	Kill - gomphothere	Desert Southwest	Clovis points and other lithics	Sánchez *et al.* (2014)
Escapule, (AZ-EE-8:28), Cochise County, AZ	Kill - mammoth	Desert Southwest	Clovis points	Hemmings and Haynes (1969)
Jake Bluff, (34HP60), Harper County, OK	Kill / Camp - bison	Southern Plains	Clovis points and other lithics	Bement and Carter (2010)
Kimmswick, (23JE2), Jefferson County, MO	Kill - mastodon	Midcontinent and Great Lakes	Clovis points and other lithics	Graham *et al.* (1981)
Lange-Ferguson, (39SH33), Shannon County, SD	Kill - mammoth	Northern Plains	Clovis points and evidence of bone modification	Hannus (1990)
Lehner, (AZ-EE-12:1), Cochise County, AZ	Kill- mammoth	Desert Southwest	Clovis points and other lithics	Haury *et al.* (1959)
Leikem, (AZ-FF-9:2), Cochise County, AZ	Kill / Isolate - mammoth	Desert Southwest	Clovis point, possibly from the Lehner kill site	Johnson and Haynes (1967)
Miami, (41RB1), Roberts County, TX	Kill - mammoth	Southern Plains	Clovis points, excavated in 1937, another very early man/mammoth site	Sellards (1938, 1952) Holliday *et al.* (1994)
Murray Springs, (A-EE-8:25), Cochise County, AZ	Kill / Camp - mammoth & bison	Desert Southwest	Clovis points and other lithics	Haynes and Huckell (2007)
Naco, (AZ-FF-9:1), Cochise County, AZ	Kill - mammoth	Desert Southwest	Clovis points	Haury *et al.* (1953)
Sloth Hole, (JE121). Jefferson County, FL	Kill / Camp - mastodon	Middle-Atlantic / Southeast	Clovis variant, one of the three oldest Clovis sites, submerged deposits	Hemmings (2005) Webb (2006)
Clovis and Clovis-aged fluted points with dated deposits				
Anzick, (24PA506), Park County, MT	Cache	Northern Plains	Clovis variant points, other lithics, ivory rods and human remains	Wilke *et al.* (1991) Morrow and Fiedel (2006)
Aubrey, (41DN479), Denton County, TX	Camp	Southern Plains	Clovis point and other lithics, butchered bison bones in multiple occupation levels, one of the oldest Clovis sites	Ferring (1995, 2001)

Casper, (48NA304), Natrona County, WY	Surface	Northern Plains	Clovis point recovered with camel remains, no direct association	Frison (1974)
Cactus Hill, (44SX202), Sussex County, VA	Camp	Middle-Atlantic / Southeast	Clovis points, and other lithics, also is good pre-Clovis candidate	Wagner and McAvoy (2004)
Debert, Nova Scotia, CAN	Kill / Camp - caribou	Northeast	Clovis point variant, and other lithics	MacDonald (1968) Hamilton and Buchanan (2007)
Klein, (5WL1368), Weld County, CO	Surface / Kill	Northern Plains	Clovis points and other lithics, possibly associated with mammoth and horse	Zier *et al.* (1993)
Paleo Crossing, (33ME274), Medina County, OH	Camp	Midcontinent and Great Lakes	Clovis points and other lithics	Brose (1984)
Shawnee-Minisink, (36MR43), Monroe County, PA	Camp	Northeast	Clovis points and other lithics, largest organic assemblage excavated	Gingerich (2011) McNett (1985a)
Sheriden Cave, (33WY252), Wyandot County, OH	Kill / Camp	Midcontinent and Great Lakes	Clovis point, bone tools Direct evidence with giant beaver	Tankersley (1997) Waters *et al.* (2009)
Stratified deposits with diagnostic Clovis artefacts				
Adams, (15CH90), Christian County, KY	Quarry / Workshop / Camp	Middle-Atlantic / Southeast	Clovis points, preforms and other lithics, single component site	Sanders (1988, 1990) Gramly and Yahnig (1991)
Big Bone Lick, Boone County, KY	Kill ? / Camp	Southeast	Clovis points possibly in association with mammoth	Tankersley (1985, 1989) Tankersley *et al.* (2009)
Big Eddy, (23CE426), Cedar County, MO	Camp	Midcontinent and Great Lakes	Clovis points and other lithics. Gainey / Clovis	Ray *et al.* (1998)
Carson-Conn-Short, (40BN190), Benton County, TN	Camp / Workshop	Middle-Atlantic / Southeast	Clovis points recovered from site and in immediate vicinity, other Clovis lithics present	Broster and Norton (1993) Norton and Broster (2009) Broster *et al.* (2013)
Coates-Hines, (40WM31), Williamson County, TN	Kill / Camp	Middle-Atlantic / Southeast	Clovis lithics in direct association with mastodon remains	Deter-Wolf *et al.* (2011)
Drake, (5LO24), Logan County, CO	Cache	Northern Plains	Clovis points and a hammerstone, points show little sign of usage	Stanford and Jodry (1988)
East Wenatchee, (45DO432), Douglas County, WA	Cache	Northwest	Large Clovis points, preforms, and bifaces	Mehringer and Foit (1990) Gramly (1993)
Gault, (41BL323), Bell County, TX	Camp	Southern Plains	Clovis points and other lithics, also a good pre-Clovis candidate	Collins (2002) Waters *et al.* (2011a)
Lamb, Genesee County, NY	Camp / Cache?	Northeast	Clovis points and other lithics. Possible biface cache	Gramly (1999)
Lewisville, (41DN72), Denton County, TX	Camp	Southern Plains	Possibly one of the oldest Clovis sites. Clovis point, other lithics and hearths	Crook and Harris (1957, 1958)
Sheaman, (48NO21), Niobrara County, WY	Camp / Surface	Northern Plains	Clovis point, biface, blades, and knapping debris	Frison (1982)
Simon, (10CM7), Camas County, ID	Cache	Northwest	Clovis points and biface blanks	Butler (1963) Woods and Titmus (1985)
Sugarloaf, Franklin County, MA	Camp	Northeast	Clovis points and other lithics	Gramly (1998, 2014)
Thunderbird, (44WR11), Warren County, VA	Quarry / Workshop / Camp	Middle-Atlantic / Southeast	A multi-activity, multicomponent site, with Clovis preforms and broken late-stage fluted points	Gardner (1974) Carr *et al.* (2013b)
Topper, (38AL23), Allendale County, SC	Camp	Middle-Atlantic / Southeast	Clovis points and other lithics, bone and ivory tools	Smallwood *et al.* (2013)

Williamson, Dinwiddie County, VA	Quarry / Workshop / Camp	Middle-Atlantic / Southeast	A large multi-activity campsite within a large quarry	McCary (1951) Hill (1997)
Dated Clovis-era sites without diagnostic Clovis artefacts, see Table. 2.2				
Arlington Springs, CA-SRI-173), Santa Rosa Island, CA	Camp (occupational)	Great Basin	Possible human remains dating to Clovis	Johnson *et al.* (2000)
Bonneville Estates Rockshelter, (26EK3682), Elko County, NV	Camp (habitation)	Great Basin	Multicomponent rockshelter with evidence of hunting and butchery, no lithics	Goebel *et al.* (2007) Graf (2007)
Casper, (4NA304), Natrona County, WY	Isolate / Surface-collected	Northern Plains	Clovis point, not in direct association with the camel remains	Frison (1974)
Indian Creek, (24BW626), Broadwater County, MT	Camp (seasonal)	Northern Plains	Multicomponent site, Clovis - Folsom transitional association. Dates from layer with Clovis artefacts	Davis (1984) Davis & Baumler (2000)
Kanorado, Sherman County, KS	Kill / Camp	Southern Plains	Clovis and potential pre-Clovis activity. Butchery evidence	Mandel *et al.* (2005)
Lubbock Lake, (41LU1), Lubbock County, TX	Kill / Camp	Southern Plains	No diagnostic artefacts, does have Clovis activity and a credible Clovis date	Johnson and Holliday (1985) Johnson (1987)
Union Pacific Mammoth, Carbon County, WY	Kill?	Northern Plains	Clovis-aged lithics, unfluted point, in direct association with mammoth remains	Haynes *et al.* (2013)
Surface sites with Clovis and Clovis-aged artefacts				
Borax Lake, (CA-LAK-36), Lake County, CA	Camp	Great Basin	Clovis flutedpoints and other lithics recovered from the surface	Harrington (1948)
Bull Brook, (19ES80), Essex County, MA	Camp	Northeast	Clovis point variant and other lithics	Byers (1954)
Bull Brook II, (19ES80), Essex County, MA	Camp	Northeast	Clovis point variant and other lithics	Grimes *et al.* (1984)
Dietz, (35LK1529), Lake County, OR	Camp	Northwest	Clovis points and other lithics	Willig (1988) Pinson (2008)
Eckles, (14JW4), Jewell County, KS	Camp	Southern Plains	Clovis points and other lithics recovered from a surface locality, possibly near a kill site	Holen (2010)
Fenn Cache, UT/WY/ID border	Cache	Northern Plains	Large cache of Clovis and Clovis variant points and other lithics. Some doubt on authenticity and discovery	Frison and Bradley (1999)
Hell Gap, (48GO305), Goshen County, WY	Camp / Surface	Northern Plains	Clovis points discovered with mammoth remains within 5 miles of the site	Irwin-Williams *et al.* (1975)
McFaddin Beach, (41JF50), Jefferson County, TX	Isolates / Surface	Southern Plains	Clovis points and other artefacts washed up on the shoreline. Possibility of undisturbed buried sites	Turner and Tanner (1994) Stright *et al.* (1999)
Mockingbird Gap, Socorro County, NM	Camp	Desert Southwest	Clovis points and other lithics, surface site. Large amount of basal sections	Holliday *et al.* (2009) Hamilton *et al*. (2013)
Mueller-Keck, (11S593 & 11S1319), St. Clair County, IL	Camp / Surface	Midcontinent and Great Lakes	Two large Clovis campsites, possibly the same site, processing and maintenance areas	Amick and Koldehoff (2005)
Plenge, (28WA636), Warren County, NJ	Camp	Northeast	Clovis point variant	Kraft (1973) Gingerich (2013b)
Ready / Lincoln Hills, (11JY46), Jersey County, IL	Quarry / Camp	Midcontinent and Great Lakes	Clovis points, preforms and other lithics, the assemblage represents the full range of Clovis fluted point manufacture	Howard (1988) Morrow (1995)

Rummells-Maske, (13CD15), Cedar County, IA	Camp / Cache	Midcontinent and Great Lakes	Clovis points, biface blanks and preforms, surface-collected	Anderson and Tiffany (1972) Morrow and Morrow (2002b)
Shoop, (36DA20), Dauphin County, PA	Kill / Camp	Northeast	Clovis points and other lithics	Witthoft (1952) Cox (1986)
Vail, Oxford County, ME	Kill / Camp	Northeast	Clovis point variant and other lithics	Gramly (1982)

[1] *A complete list of all North American State abbreviations can be seen in Appendix. D*

Table. 2.1 Key sites and assemblages that help to define the current understanding of Clovis. The Clovis point assemblages that are included in my analysis and are a part of my complete sample; that is either sample 1); sample 2); or sample 3) (see Chapter 3) are highlighted in bold. Modified from Miller et al. (2013)

After the discovery of the fluted points at the Clovis type site, points with the same characteristics were recognised and reported throughout North America (*e.g.* Wormington 1957; Haynes 1964; Anderson and Faught 1998, 2000; Sánchez 2001; Anderson *et al.* 2005, 2010), and many of the early discoveries were associated with the bones of extinct megafauna, which according to Martin (1943) contributed to their extinction (but also see Grayson and Meltzer 2003, 2015; Surovell *et al.* 2016). There are at least fourteen sites with clear associations of remains from extinct mammoth and mastodon with artefacts, mainly Clovis fluted points (Grayson and Meltzer 2002; Waguespack and Surovell 2003; Surovell and Waguespack 2008). More sites with clear evidence for bison hunting can be added to the list of fourteen (Table. 2.5). The association of megafauna predation provided the basis for several models concerning the peopling of North America and the appearance of Clovis with the predation of large mammalian species that subsequently became extinct (Haynes 1969; Kelly and Todd 1988).

The difficulties in identifying Clovis fluted points has been an unfortunate failing among many researchers and has led to confusion and uncertainty in our efforts to understand the appearance of Clovis and ultimately its definition. Although there is a considerable variation among those points generally accepted as being Clovis, other later fluted forms i.e., Folsom, Gainey, and Cumberland [4] etc, are better defined and do not have too much variability, but are still debated as to what is their relationship to Clovis and each other (Morrow and Morrow 2002a; Bradley *et al.* 2010:2). The question of what Clovis is and where the boundaries should be drawn has proven to be a complicated one.

Analyses of stylistic variability that could help us understand the problems associated with defining Clovis have been hampered by our methods of classification (Haynes 1983; Howard 1990). Different investigations focus on different technological or stylistic attributes in defining groups of points and end up overlooking or discounting other researchers' work, even when describing the same forms (*e.g.* Tompkins 1993). At least part of the problem is inherent in archaeological inquiry; a point is discovered by one archaeologist in one region and is named from that area, while another similar find by a different individual somewhere else is called something completely different (Flenniken and Raymond 1986).

In the last few decades, Clovis points and regional variability have been at the centre of considerable research (see Morrow and Morrow 1999; Anderson and Faught 2000; O'Brien *et al.* 2001, 2012; Ellis 2004; Buchanan and Collard 2007, 2010; Buchanan and Hamilton 2009; Prasciunas 2011; Buchanan *et al.* 2012a, 2014; Sholts *et al.* 2012; Smallwood 2012; Gingerich 2013a, 2018; Bradley and Collins 2013; Miller *et al.* 2013; Eren *et al.* 2014a, 2015; Amick 2017). At present there are two main theories concerning Clovis fluted point variability on a regional basis. The "*regional environmental adaptation hypothesis*" proposes that Clovis-era groups adapted their hunting toolkit to the characteristics of their prey and local habitat, which ultimately resulted in regional differences within these toolkits, which would have included variation in the Clovis fluted points. This is not an entirely new concept

[4] However, there has been suggestions that the earliest appearance of Cumberland is older than Clovis and that the origin of fluting lies within the Cumberland Tradition which developed in southeastern North America (Gramly 2009b), see the Dutchess Quarry Cave site in New York, and Phil Stratton site in Kentucky (Appendix. A), many of the Cumberland points resemble the later Barnes points and Crowfield points (see also Boldurian and McKeel 2011)

and the origins of this idea can be traced back to Whithoft (1952, 1954). This hypothesis gained further support during the 1980s and early 1990s (*e.g.* Meltzer 1988, 1993; Anderson 1990b; Storck and Spiess 1994), when researchers concluded that Clovis groups developed different cultural adaptations within diverse environments in eastern North America. More recently Smallwood (2012) did an examination of points and bifaces from sites located in Tennessee, South Carolina and Virginia, and identified differences in point morphology and a degree of variation within each subregion. Interestingly, Smallwood identified that the most significant variable within these points was the depth of basal concavity, and concluded that the variation in basal morphology could have been the result of individual styles of knapping (Smallwood 2012:707).

In another study it was suggested that the particular prey being exploited had an effect on the size and shape of Paleoindian points (Buchanan *et al.* 2011). Therefore, it might be that Clovis fluted point variability may have been adapted to the different prey Clovis hunter-gatherers were hunting in the different regions of North America. Zooarchaeological evidence suggests that in eastern North America caribou or deer was the primary prey, whereas in the western and plains regions it primarily mammoth and bison (Spiess 1979; Cannon and Meltzer 2004). A comparative analysis on the assemblages from Clovis sites with associated fauna will be a good test of this hypothesis and the analysis and results will be presented below.

The alternative hypothesis put forward suggests that Clovis groups did not alter, or produce specific shapes of their points in relation to local environmental conditions. This "*continent-wide adaptation hypothesis*" was first outlined in the 1950s (Byers 1954; Willey and Phillips 1958), but it is best recognised by the work done later by Haynes (1964) and Kelly and Todd (1988). Recently, two studies have produced results that are consistent with the continent wide adaptation hypothesis. Buchanan and Hamilton (2009) looked at whether

Clovis fluted point shape correlated with regional diversity. They found no association between point shape and regional environmental variability, and interpreted their conclusions as that not enough time had elapsed during the Clovis expansion for there to be local point shape variability present.

Sholts *et al.* (2012) used a laser scanning technique to examine flake scar patterns on Clovis fluted points from the Great Plains, Southwest and Middle-Atlantic regions. They concluded that there were few differences among the sample and argued that it supported widespread standardisation of Clovis technology. Gingerich (2013a, 2018) has been working on the northeastern fluted point assemblages from sites that are, or have been reported as having Clovis fluted point variants, the Bull Brook sites in Massachusetts, the Plenge site in New Jersey, and the West Athens Hill site, also in New Jersey. These sites have been in the archaeological record for some time but recently have been revisited and now are attributed to Clovis (Gingerich 2013a, 2018; Miller and Gingerich 2013).

2.2 Dating: what is the age of Clovis?

Clovis is regarded as the oldest undisputed evidence of humans in the Americas (but see Haynes 2002; Madsen 2015) and although Clovis covers a broad geographical area, only twenty-two sites in North America have been directly ^{14}C dated (Waters and Stafford 2007), a further six sites with accepted ^{14}C yr BP dates were added which were not previously evaluated (Hamilton and Buchanan 2007). The ^{14}C dates from these sites traditionally placed Clovis between 11,500 and 10,900 ^{14}C yr BP. At least another six sites can be added, but have problematic dates and do not provide accurate or precise chronological data in determining the age for Clovis (Waters and Stafford 2013), and finally I added a further seven sites to the table below that have credible dates and had Clovis points that appeared in my analysis (Table. 2.2). For several reasons, some not apparent, these were omitted from previous Clovis dating publications, but I chose to include them in my dating review.

SITE	^{14}C yr BP	Cal yr BP Min	 Max	DATED MATERIAL	COMMENTS	PRIMARY DATE SOURCE
Clovis sites with accepted dates and diagnostic artefacts						
Lange-Ferguson, SD	11,080 ± 40	12, 942	13,046	Mammoth bone and charcoal	5 dates obtained, 2 disregarded	Waters and Stafford (2007)
Sloth Hole, FL	11,050 ± 50	12,912	13,026	Mastodon tusk	I date from ivory tool	Waters and Stafford (2007)
Anzick, MT	11,040 ± 35 10,705 ± 35	12,902 12,707	12,994 12,556	Mammoth bone (tool) Human bone	2 dates obtained from bone foreshaft 12 dates obtained, 11 rejected	Waters and Stafford (2007) Rasmussen *et al.* (2014)
Dent, CO	10,990 ± 25	12,888	12,933	Mammoth bone	9 dates obtained, 6 disregarded	Waters and Stafford (2007)
Paleo Crossing, OH	10,980 ± 75	12,857	12,968	Charcoal	10 dates obtained, seven rejected	Waters and Stafford (007)
Domebo, OK	10,960 ± 30	12,873	12,917	Mammoth bone	Numerous dates were obtained	Waters and Stafford (2007)
Lehner, AZ	10,950 ± 40	12,866	12,916	Charcoal	All 12 dates were accepted	Waters and Stafford (2007)
Shawnee-Minisink, PA	10,935 ± 15	12,867	12,899	Seeds	9 dates obtained from hearth, 4 rejected	Waters and Stafford (2007)
Murray Springs, AZ	10,885 ± 50	12,838	12,887	Charcoal	All 8 dates were accepted	Waters and Stafford (2007)
Colby, WY	10,870 ± 20	12,841	12,870	Mammoth bone	5 dates obtained, 3 rejected	Waters and Stafford (2007)
Jake Bluff, OK	10,765 ± 25	12,802	12,833	Bison bone	3 dates obtained, all accepted	Waters and Stafford (2007)
Clovis sites with unaccepted [1] dates and Clovis diagnostic artefacts						
Casper, WY	11,190 ± 50	13,043	13,169	Camel bone	No artefacts were recovered from the camel bonebed	Frison (2000)
East Wenatchee, WA	11,125 ± 130	12,920	13,130	Charcoal	Volcanic ash found underneath artefacts	Davis and Baumler (2000)
Big Eddy, MO	10,830 ± 60	12,814	12,869	Charcoal	Sample from floor (Clovis component)	Ray *et al.* (1998)
Hiscock, NJ	10,795 ± 40	12,809	12,848	Caribou and mastodon bone	Dates obtained from culturally modified bone	Laub (2002, 2003)
Vail, ME	10,710 ± 50	12,735	12,823	Charcoal	Sample from habitation area	Gingerich (2007)
Debert, Nova Scotia, CAN	10,590 ± 50	12,413	12,445	Charcoal	Sample from hearths, spruce	Haynes *et al.* (1984)
Hedden, ME	10,550 ± 40	12,401	12,471	Charcoal	Sample from pine and spruce	Asch Sidell (1999)
Problematic Clovis-age sites with diagnostic artefacts						
Aubrey, TX	11,570 ± 70	13,307	13,473	Charcoal	Samples taken from eroded area	Ferring (2001)
El Fin del Mundo, Sonora, MEX	11,550 ± 60	13,384 avg		Charcoal, shell, and other organics. Gomphothere tooth	Gomphothere tooth enamel	Sánchez *et al.* (2014)
Wally's Beach, Alberta, CAN	11,350 ± 80 10,980 ± 80	no Cal dates available [2]		Bone collagen from bison, horse, musk oxen, and caribou	Clovis points and other lithics, horse and camel butchery association	Waters and Stafford (2007)
Blackwater Draw, NM	11,300 ± 235	no Cal dates available		Organics	5 samples taken, 2 rejected	Waters and Stafford (2007)
Union Pacific, WY	11,280 ± 350	no Cal dates available		Mammoth Ivory	Clovis association is likely	Waters and Stafford (2007)
Sheaman, WY	11,220 ± 50	13,080	13,185	Purified collagen Charcoal	The collagen sample come from a cervid bone point	Haynes *et al.* (2004)

Big Bone Lick, KY	11,020 ± 30 10,600 ± 259	12,880 12,160	13,039 12,840	Mastodon bone and wood charcoal	Several dates obtained, some rejected, min / max ages	Tankersley *et al.* (2009)
Cactus Hill, VA	10,920 ± 250 Clovis levels	no Cal dates available		Charcoal	Sample from hearth	Waters and Stafford (2007)
Sheriden Cave, OH	10,915 ± 30 (revised date)	12,925	13,025	Collagen from bone tool	Bone points and other ivory tools, Clovis points.	Waters *et al.* (2009)
Gault, TX	no ^{14}C dates available	12,200	13,600	OSL dates of 12,900 ± 700 BP	Silt-sized quartz grains	Rodrigues *et al.* (2016)
Clovis-age sites that have diagnostic artefacts but not approved dates						
Lewisville, TX	~ 11,000	no Cal dates available		Charcoal	Samples from carbonised material from the hearths	Crook and Harris (1962) Stanford (1982)
Dietz, OR	~ 11,000	no Cal dates available		Charcoal	Clovis diagnostic artefacts, including points, laid over lake deposits	Pinson (2008, 2011)
Bull Brook, MA	10,410 ± 60 10,380 ± 50	no Cal dates available		Cervid bone	Cervid long-bone	Robinson *et al.* (2009)
Sugarloaf, MA	10,350 ± 50	no Cal dates available		Cervid bone	Cervid long-bone	Gramly (2015)
Coats-Hines, TN	10,260 ± 240 Above mastodon 12,030 ± 40 Below mastodon	no Cal dates available		Charred material and mastodon bone	Both taken from mastodon B deposits	Deter-Wolf *et al.* (2011)
Clovis-aged sites that have no diagnostic artefacts						
Lubbock Lake, TX	11,100 ± 60	12,949	13,071	Wood and charcoal	Samples taken from several intact deposits	Johnson (1987)
Bonneville Estates, NV	11,010 ± 40	12,886	12,959	Charcoal	Samples taken from hearth debris	Waters and Stafford (2007)
Kanorado, KS	10,980 ± 40	12,878	12,935	Bone collagen from mammoth	Samples from a reported Clovis horizon	Mandel *et al.* (2005)
India Creek, MT	10,980 ± 110	12,850	13,000	Charcoal	Sample from the earliest level	Davis and Baumler (2000)
Arlington Springs, CA	10,960 ± 80	12,848	12,955	Bone collagen from human remains		Waters and Stafford (2007)

[1] *When I refer to unaccepted dates, these are dates that did not appear in either of the dating papers referred to in section 2.2*
[2] *No accurate Cal yr BP dates were available, but see Table. E.1 in appendices, for conversion*

Table. 2.2 Clovis sites with reliable and problematic radiocarbon dates. Sites listed in bold represent assemblages of Clovis points in my analysis. After Hamilton and Buchanan (2007) and Waters and Stafford (2007,2013)

The re-evaluation of the ^{14}C dates place the beginning of Clovis at ~11,050 using Lange Ferguson, South Dakota as the oldest dated site at 11,080 ± 40 ^{14}C BP, to ~10,800 using Jake Bluff, Oklahoma as the youngest dated at 10,765 ± 25 ^{14}C BP. The oldest date reduced former estimates by 450 ^{14}C years, and the youngest by 100 ^{14}C years. Using the youngest available date from the oldest site, and the oldest available date from the youngest, a span of just 200 years has been suggested for the length of Clovis. The ages for all Clovis sites overlap within this 200-year time-scale, and probably represent an accurate range of Clovis in

North America (Waters and Stafford 2007). From the sites with the most accurate and precise dates (Table. 2.2), a range from 11,080 ± 40 ^{14}C BP to 10,765 ± 25 ^{14}C BP, or ~13,000 ^{14}C to ~12,800 yr BP provides a date range for Clovis. It is a small sample size, but it is all that there is to work from. More thorough efforts of dating is required as more Clovis sites continue to be discovered or reinvestigated (Waters and Stafford 2013).

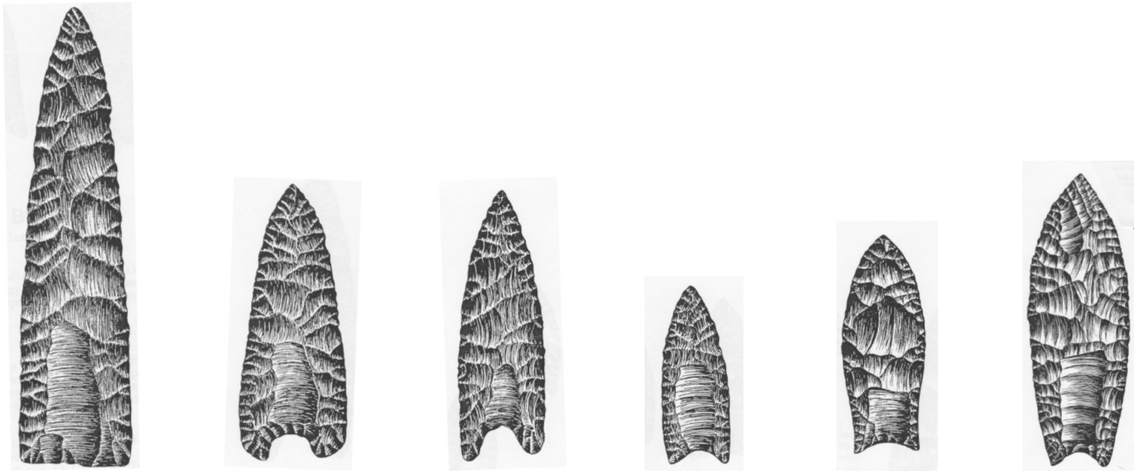
2.3 Regional distribution of Clovis fluted points

For my analysis on the distribution of Clovis points in North America, I identified seven regions which were selected after researching Clovis sites and Clovis point locations for my literature review (Figure. 2.1). The regional boundaries followed the definitions from several previous studies and were loosely adapted (Haynes 2002; Miller *et al.* 2013; Buchanan *et al.* 2014). As the archaeological record is primarily state-based, these regions are outlined by their political administrative boundaries.

Before I carried out my analysis on the regional variability within Clovis points, several variants were already in the archaeological record and were identified in the literature. These are the traditional recognised type, sometimes called 'true' or ‘classic’ Clovis, some researchers term these traditionally Clovis points as western Clovis (*e.g.* Morrow 2005a,b), which I suggest is misleading, as it implies that these points come from northwest, or southwest North America, when actually they come from the Northern and Southern Plains and Desert southwest. There are the Eastern Fluted Tradition Clovis forms from the woodlands in the Northeast region, the deep-based variants of the Northeast, the waisted Clovis and Ross County Clovis from the Southeast and Great Lakes, the St. Louis Clovis of the Middle-Atlantic, and western Clovis points from the Great Basin, and an unfluted Clovis point variant (Figure. 2.2; Tables. 2.3; 6.2). These point types all come from the Clovis-aged time period that I referred to in Chapter 1 (also see Table. 2.2). All of these, and a couple more that I will cover below, are all represented in my complete sample, which I will reclassify and rename, where necessary after my analysis, and suggest a more simple and straightforward classification of Clovis points. There may well be more variants that I have missed or misidentified, but with this research it may be possible to add to the bigger picture in our understanding of Clovis point variability on a regional and continental wide scale.

POINT	FORM / TYPE	REGIONAL DISTRIBUTION	KEY SITES	COMMENTS AND DESCRIPTION	PRIMARY SOURCE
Classic Clovis: Figure. 2.1 (a-f)	Clovis type point	all regions, but the majority are found in the Northern and Southern plains, Desert Southwest and Midcontinent	Blackwater Draw, NM; Miami, TX, San Pedro Sites, AZ; Dent, CO, Kimmswick, MO	lanceolate fluted point, slightly concave base and base and lateral grinding	Wormington (1957); Hester (1972); Howard (1990)
Colby Clovis - Deep-based Clovis: Figure. 2.2 (b)	Clovis variant	Northern Plains	Colby, WY; Fenn Cache, UT/WY/ID border	deep basal concavities and rounded basal ears	Frison (1978)
Debert / Vail Clovis - Deep v-based Clovis: Figure. 2.2 (c)	Clovis variant	Northeast	Debert, Nova Scotia; Vail, ME; Bull Brook, MA; Lamb, NY	deep v-shaped to u-shaped concave bases	McDonald (1968)
Bull Brook Clovis - Triangular blade Clovis: Figure. 2.2 (d)	Clovis variant	Northeast	Bull Brook II, MA; Shoop, PA; Plenge, NJ	medium to small parallel-sided to triangular blade section	Byers (1954)
Anzick Clovis - Straight-based Clovis: Figure. 2.2 (a)	Clovis variant	Northern Plains, Northwest	Anzick, MT; Simon, ID	large triangular with a straight basal edge. Typically short flutes in relation to overall length	Wilke *et al.* (1991)
Ross County - Waisted Clovis style: Figure. 2.2 (e)	Clovis variant	Midcontinent & Great Lakes	Hardin County, OH; Pike County, IL; Clay County, AR	thick medium sized points with the widest part in the mid-section. Distinctive flat flake scars on both faces. lateral edges constrict towards basal corners	Prufer & Baby (1963)
Waisted Clovis - Southeast Clovis: Figure. 2.2 (e)	Clovis variant	Middle-Atlantic & Southeast, Southern Plains, Desert Southwest	Silver Springs and Sloth Hole, FL; Camp Pecomoth, MD; Gault and McFaddin Beach, TX; Murray Springs, AZ	see Ross County for description	Neill (1958)
St. Louis Clovis Figure. 2.2 (f)	Clovis variant	Midcontinent & Great Lakes, Middle-Atlantic & Southeast	Belgreen, AL	large thin fluted point, convex sides contracting to the basal edge, wide flat flutes	Perino (1985)
Western Clovis	Clovis variant	Great Basin	Borax Lake, CA	originally named a crude form of Folsom, it is fluted and has concave bases	Harrington (1948)
Unfluted Clovis	Clovis variant	Southern Plains and Desert Southwest, Middle-Atlantic & Southeast, Southwest	Bull Creek, OK; Bigbee, NM; Page-Ladson, FL; Fenn Cache, UT/WY/ID border	typically very similar to the Classic Clovis form, without the fluting	Haynes (1955) Frison and Bradley (1999) Puseman (2004) Dunbar (2006, 2007) Thomas *et al.* (2017)

Table. 2.3 Clovis variants from across the seven regions in North America (see Figure. 2.1) before my reclassification (see Table. 6.2)



a b c d e f

Figure. 2.2 Examples of Clovis point variation: a) Anzick; b) Colby; c) Debert; d) Bull Brook; e) waisted / Ross County Clovis; f) St. Louis Clovis. Modified from Perino (1985)

In the sections below I will give a brief description of the location and environment of the region, the key sites and point assemblages that I will use in my sample analysis. A broader more comprehensive overview of Clovis occurrences and associations in each respective region that do not directly relate to my analysis can be seen in the appendices as supporting information (Appendix A), and a detailed overview of the lithic raw materials present at each site is presented in Chapter 4.

In the region descriptions below I refer to the three types of sample I have. In brief these are:-

1) my main point sample

2) my comparative sample

3) a supplementary sample

These samples will be discussed further in Chapter 3.

2.3.1 Region 1: Northeast

The Northeast region as described in this study is almost 550,000 sq km in area. It includes Nova Scotia and the states of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, and Pennsylvania (Figure. 1.1). The region varies geographically with a coastal plain on the Atlantic Ocean side, an inland ridge and valley with the relatively high northern Appalachians and upland plateau. Most of the post Last Glacial Maximum (LGM) vegetation was forest, the likely fauna being woodland species; such as black bear, white tailed deer, turkey, moose, mammoth and mastodon and north of Massachusetts, woodland caribou (Spiess 1979; Martin and Klein 1984; Haynes 2009).

Many of the Clovis sites in this region have been found through modern agricultural intervention, called 'plowzone occurrences' (Haynes 2002:41). The highest percentage of Clovis points coming from Massachusetts, New York, New Jersey, and Pennsylvania in that order (Anderson and Faught 1998; Anderson *et al.* 2010). It is argued (Meltzer 1988; Lepper and Meltzer 1991) that there is quite a significant difference in Clovis points between the northern and the central/southern areas of this region. Meltzer notes that isolated fluted points occur in higher numbers in the central southern area than in the north (Meltzer 1991:177) and there are relatively fewer sites in the south and central forests, perhaps a reflection of different Paleoindian land use and adaptation.

The tundra and spruce woodland in the north and deciduous and boreal forests in the south led to the debate of whether Clovis groups in this region were generalists or specialists (Meltzer 1988; Lepper and Meltzer 1991). The two major paleoenvironments in this region provided different adaptive strategies for the Clovis groups. In the north caribou were being exploited, whilst down south it was deer (Meltzer 1988). This has been supported by the faunal remains at the sites in the regions. And it seems that the Clovis people were exploiting whatever resources were available in any particular area. Dincauze (1993a) and Curran (1999) argue that from the archaeological evidence, such as the number of fluted points in individual site assemblages represent different Clovis dispersal phases in the northeast. The first phases being early exploration followed by colonisation and settlement of the resource areas. Certain large resource sites such as the two phases of occupation at Bull Brook, Massachusetts; Templeton, Connecticut; and the Whipple site in New Hampshire could represent the first residential settlements in this region from which to explore and forage further afield (Curran 1999). The latter two sites will be discussed further in the supporting information (Appendix. A). Bull Brook (19ES80) [5] was discovered near Ipswich, Essex County (Tables. 2.1; 3.1), Massachusetts, in 1951 (Byers 1954, 1955), and represents one of the largest Paleoindian sites in North America. It is a large campsite and has many activity areas (Grimes 1979). Over a thousand implements were recovered, including about fifty fluted pieces, five of which were complete. The tools were made on regionally local cherts and jasper; however the exact source of the material is yet to be located (Grimes 1979).

Bull Brook II is approximately 300 m southwest of the main site. With the discovery of the Bull Brook II site in 1956 (Grimes *et al.* 1984), attention was given to the area separating the two locales, although later industries were recovered no Paleoindian artefacts were present. The lithic assemblage from Bull Brook II includes all of the known artefacts found at Bull Brook, however, only a single Clovis point was found, and the assemblage differs only slightly in the number of tools present. The varieties of lithic raw materials used to produce the artefacts are also the same as that at Bull Brook.

[5] These references are called trinomials, and in some U.S. States they are unique archaeological site references. The first two numbers refer to the U.S State Index, in this case Massachusetts being the 19th state. The two letters are the County abbreviation, Essex County, and the number at the end is the registered archaeological site record number (Appendix. C)

The activity areas in Bull Brook were spaced 10-15 meters apart, situated in a rough circle c. 100 meters in diameter, whereas the loci at Bull Brook II were more closely packed, 0-2 meters apart, and arranged linearly (Grimes *et al.* 1984). Although the two sites share a number of features, lithological and typological, which suggests a close cultural relationship, differences between the two sites do exist, principally within the intra-site structuring.

Recent reinterpretations of the dating of the Bull Brook site (Gramly 2015) with another site in Massachusetts, the Sugarloaf site (Gramly 1998, 2014), puts these two sites as being younger than the recognised Clovis-age site at Jake Bluff, Oklahoma (Table. 2.2). The Bull Brook ^{14}C dates from the calcined bone are 10,410 ± 60 and 10,380 ± 50 ^{14}C yr BP (Robinson 2009), whilst the dates for the Sugarloaf site are 10,350 ± 50 ^{14}C yr BP (Table. 2.2), and also from calcined cervid bone (Gramly 2015). If correct, these dates make the Bull Brook and Sugarloaf sites the youngest Clovis sites in North America (Gramly 2015**.** Gramly does refer to an 'old' Bull Brook phase (Gramly 2015:105) first observed in the original investigations (Jordan 1960), so perhaps there are two or more lithic components present at the site, and some of the fluted points are indeed Clovis, or Clovis-aged. The Sugarloaf site and the lithic assemblage are discussed further in the supporting information (Appendix. A). However, based on my initial study of the material and the published archaeological literature, it is my suggestion is that the sugarloaf fluted points are indeed Clovis, and several of points will go through my analysis below (see Gramly 2015).

The Lamb site Genesee County (Tables. 2.1; 3.1), in eastern New York State, was first discovered in 1965 (Gramly 1999). It is a large campsite that yielded an assemblage of Clovis points and bifaces. Some of these points have been reworked and modified; whether the modifications these points underwent influenced the shape of these points from their original form is uncertain, but as my analysis concentrates on basal morphology, it does not have a significant bearing on my variability analysis. However, according to Bradley (Bradley *et al.*

2010:102) most Clovis points exhibit some evidence of reworking. The Lamb site perhaps represents the only evidence in the region for Clovis caches and is also in contrast to other caches in that it has been found in a campsite whereas other Clovis caches are normally found in isolation (Kilby and Huckell 2013).

The Shoop site (36DA20) in Dauphin County (Tables. 2.1; 3.1) Pennsylvania (Whithoft 1952; Cox 1986) is a large campsite or processing site where caribou was the main fauna exploited. The Shoop site has been surface-collected by both professional and avocational (amateur) archaeologists since its discovery in the 1930s. Every visible artefact was collected, including all the knapping debris and micro-debitage less than 5 mm in size (Cox 1986). The use of non-local raw material when there are local sources of quite adequate material suggest that the Clovis groups were visitors, possibly frequently, following the herds in seasonal migrations. If that is the case, then it also suggests that these groups were migrating in following caribou and / or deer herds, and not the descendants of a pre-Clovis populations.

One other site from this region also from Pennsylvania is Shawnee-Minisink (McNett 1985a). The site (36MR43) in Monroe County (Tables. 2.1; 3.1) is located at the confluence of the Delaware River and Brodhead Creek in the Upper Delaware Valley of northeastern Pennsylvania. The site was discovered in 1973 (Kline 1985) No large mammal bones were present at the site, but is best known to have some of the earliest archaeologically recovered plant remains recovered in North America (Gingerich 2011). These seeds, along with fish bones, have helped in interpreting a more generalised subsistence strategy for early Paleoindians than was previously thought (Dent and Kauffmann 1985). The artefact assemblage contains over 30,000 lithics, mostly waste flakes and debitage. Over a hundred complete or partial tools were recovered, and all but 10% were made on local raw materials, which will be discussed further in Chapter 4. Two fluted points were recovered from the site, one in 1973 and the other from the later excavations in 2006 (Gingerich 2009). The site is important in that there are accepted ^{14}C dates of 10,935 ± 15 BP (Table. 2.2) and is one of only a few securely ^{14}C dated fluted point sites in the Northeast and Middle Atlantic regions (Carr and Adovasio 2002; Gingerich 2013c).

The Clovis-aged site of Debert in Nova Scotia (MacDonald 1968) is today about 30 km inland from the nearest coastline (Tables. 2.1; 3.1); at the time the site was occupied, sea levels were much lower and the site much further inland. The lithic assemblage at Debert has a Clovis fluted point variant; these points have very distinctive deep basal concavities with long thin basal ears (Ellis 2004). The inconsistency of the early dating of Debert originally led to the belief it was contemporary with later Paleoindian fluted point forms such as Folsom (Ellis 2004:208), but more recently it has been given a date of 10,590 ± 50 ^{14}C yr BP (Hamilton and Buchanan 2007), and it remains one of a few reliably dated fluted point sites in Canada.

The discovery of the Vail site, Oxford County (Tables. 2.1; 3.1) in northwestern Maine and the subsequent excavations of eight habitation locations, and a separate caribou butchery area suggested a large kill / campsite (Gramly 1982). The findings also led to a rethinking of the Debert site. The fluted points in the Vail assemblage were described as being *"startlingly similar"* to the Debert points (Gramly and Rutledge 1981:356); it was also noted that deep concave-based fluted points were present at Bull Brook (Robinson and Ort 2013) and at Plenge in New Jersey (Gingerich 2013b) and are part of the Paleoindian fluted points that make up the Eastern Fluted Point Tradition (Gingerich 2013, 2018; Miller and Gingerich 2013). At the time of the early excavations, it was not known whether some, all or any of the separate habitation areas were occupied at the same time, or whether it was visited seasonally. However, evidence from later excavations did support the idea that six tent-like loci were occupied simultaneously (Gramly 2009a), and there is evidence that a typical group size may have been as little as six or seven individuals (M. Gramly pers. comm. email 2016).

Refitting from debitage recovered from several of the loci cross-linked the habitation areas to each other as well as the kill site area. Very few Clovis sites can be linked by conjoined artefacts (see Haynes and Huckell 2007), and it is most likely that the Vail site's two separate areas were contemporaneous. The habitation areas Locus A-F were repeatedly used, whilst Loci G and H only once (Gramly 1982, 2009a, 2010).

The Plenge site in Warren County (Tables. 2.1; 3.1), New Jersey, was the first extensive Paleoindian occupation site to be discovered in New Jersey. Fluted points had been surface-collected but the artefacts that made up the Paleoindian toolkit went unrecognised (Kraft 1973). The site is an extensive surface site that yielded over 1,500 artefacts from Paleoindian to Archaic periods. Of these about 10% were fluted points or preforms which were at the time characterised into six different types, with a number of sub-types on the basis of morphological similarities (Kraft 1973). The raw materials may have been brought into New Jersey through direct access (direct acquisition) or by cultural behaviour such as trade or exchange systems (indirect acquisition); these processes will be discussed in more depth in Chapter 4. The initial interpretation of the Plenge site was it was a multi-temporal Clovis site, revisited periodically during Clovis times, perhaps *en route* from the Delaware River to the lake regions of northern New Jersey and into New York State (Kraft 1977). Based on the artefact assemblage it was characterised as a base camp (Eisenberg 1978), where a variety of exploitive and maintenance activities could be carried out. More recently (Gingerich 2013b) has reinterpreted the site and its fluted points.

There are very few isolate points from this region (but see Fogelman and Lantz 2006), and none that appear in my samples. However, one surface-collected Clovis point from Upper Cross Creek, Washington County, Pennsylvania (Gramly 2011), is part of my supplementary analysis (Appendix. A).

2.3.2 Region 2: Middle-Atlantic and Southeast

The Middle-Atlantic and Southeast region is almost three times the size of the Northeast region, nearly 1,450,000 sq km, and is therefore made up of two subregions:-

- the Middle-Atlantic states of Delaware, Maryland, West Virginia and Virginia
- the Southeast states of Alabama, Florida, Georgia, Louisiana, Mississippi, North and South Carolina, Tennessee, Kentucky and Arkansas

The topographic and physiography of the whole region is similar to the Northeast but with a much wider coastal plain. The other major difference is in the subtropical climate of the deep southeast. Both subregions were mainly mixed hardwood and pine woodland after the LGM and would have mostly the same fauna as the Northeast but without the caribou and moose. Bison may have been present around the Gulf Coast and in central Florida (Lundelius *et al.* 1983).

Middle-Atlantic subregion

There are very few Clovis point sites in the Middle-Atlantic region, I found there were more isolate, surface-collected points (Tables. 3.2; 5.1) than archaeological sites in this region (but see Lowery 2004; Lowery *et al.* 2010, 2012).

There are at least two large quarry / workshop sites, Thunderbird in Warren County, and Williamson in Dinwiddie County, both from Virginia. Unfortunately I did not get to see any of the points from Williamson (Table. 3.3), but I did manage to see a couple of the points from Thunderbird, and they are part of my comparative analysis and are discussed further in supporting information (Appendix. A).

The Meekins Neck campsite in Dorchester County, Maryland, has several Clovis points (Lowery and Phillips 1994), and is also part of my comparative analysis (Table. 3.2;

Appendix. A), and a fluted point from Camp Pecometh, Queen Anne's County in Maryland, (Table. 3.1), was identified when I was researching the Clovis points from the Middle-Atlantic region (Stanford and Bradley 2012). The point is an isolated surface find and is one of the waisted Clovis forms.

Cactus Hill (44SX202) in Sussex County, Virginia, is a possible candidate for pre-Clovis activity (Appendix. A.), but also has a Clovis component. The Clovis levels have diagnostic artefacts, including points (Wagner and McAvoy 2004), but lack reliable dates (Tables. 2.2; 3.1). The site sits on a stable, loamy hill consisting of mostly wind-deposited sand and silt derived from the adjacent Nottoway River floodplain, which lies to the north and west. Cactus Hill was discovered by artefact collectors in the mid-1980s before coming to the attention of J.M. McAvoy of the Nottoway River Survey and was systematically excavated from 1993 to 2002 by McAvoy and M.F. Johnson of the Archaeological Society of Virginia (McAvoy and McAvoy 1997). An overview of the toolstone present in the Clovis levels at the site is discussed in the next chapter.

Other points from the Delmarva Peninsula, an area incorporating the seaboard zones of Delaware, Maryland and Virginia, and from this subregion in general are included in my comparative samples (Tables. 3.2, 3.3; 5.1) and further information can be seen in the supporting data (Appendix. A).

Southeast subregion

In the Southeast there a few stratified Clovis sites, but since the Paleoindian Database of the Americas (PIDBA) surveys, the frequency of sites from the counties in southeastern North America has increased (Miller 2016).

Sloth Hole (8JE121) in Jefferson County, Florida (Tables. 2.1; 3.1) is a submerged site along the Aucilla River that yielded ^{14}C dates with diagnostic artefacts from a Clovis component (Dunbar 2007). A carved mastodon ivory tool fragment yielded a date of 11,050 ± 50 ^{14}C yr BP (Table. 2.2) and it is believed to be one of the oldest reliably dated Clovis sites in the Americas (Waters and Stafford 2007). Another site in the Aucilla River is Page-Ladson (Appendix. A.), both Page-Ladson and Sloth Hole have multiple Paleoindian components; only the Clovis component from Sloth Hole yielded diagnostic Clovis artefacts from an undisturbed primary context (Dunbar 2007). Sloth Hole has two Clovis fluted points that I included in my analysis. Both points represent two separate morphological forms, one is a Clovis fluted, whilst the other is a Clovis-variant termed the waisted Clovis (Table. 2.3). It was first documented after its appearance at the Silver Springs site (8MR92) in Marion County, Florida (Neill 1958), which was also the first accepted discovery of a stratified Paleoindian site in Florida. It was termed 'Clovis-like' at the time due to the point's Clovis characteristics: lanceolate, fluted, and what appeared to be overshot flaking (Dunbar and Hemmings 2004). It is thought that the later Suwannee waisted points are evolved from these points (Thulman 2007). The discovery of the Silver Springs site helped place Florida on the Paleoindian map (see Willey 1966:31; Jennings 1968:84). Sloth Hole produced several waisted Clovis forms, as well as Clovis fluted points. The waisted Clovis is an archaeological signature for the Sloth Hole site, along with the occurrence of carved ivory rods or foreshafts (Dunbar 2006).

The waisted Clovis form, although uncommon, has been reported in at least two other sites west of the Mississippi River. At McFaddin Beach in Texas (Stright *et al.* 1999), and at Murray Springs, Arizona (Haynes 1982), both discussed below in their respective regions. In eastern North America the form appears in the literature as another Clovis variant, the Ross County Clovis form (see Prufer 1962:14-21; Prufer and Baby 1963:15; Perino 1985:330). I also identified a waisted Clovis fluted point from North Carolina whilst researching the fluted points from this region. The point is unfortunately an unprovenanced isolated surface-collected find, and like so many other Clovis fluted points from North Carolina, occurred as scattered surface finds. Surveys of fluted point occurrences have been virtually the sole source for Clovis fluted point data for North Carolina (Perkinson 1971, 1973; Peck 1988; Daniel 2000). Clovis points were the predominant form of fluted point in the surveys (*n* = 196, 70%) and while the majority of these correspond to the more traditionally recognised Clovis form, there is considerable variability in size, which has been partially attributed to raw material (Daniel and Goodyear 2014). Whilst the majority of Clovis point discoveries represent isolated surface finds, there are a few occurrences of multiple point finds, indicating the likelihood of a buried stratified Clovis site (see Daniel *et al.* 2007).

An important large workshop / campsite in the subregion is the Adams site (15CH90) in Christian County, Kentucky (Table. 2.1; 3.3). It was first discovered in the mid-1950s by a local collector who discovered a small number of fluted points on the surface (Sanders 1988,1990). It lay under pasture until it was ploughed again in 1977 when Mr. C. Yahnig collected more artefacts but more importantly recognised the sites as having a single component assemblage, and reported his findings to the Kentucky Heritage Commission and donated his collection from the site (Sanders 1988). It was the first single component Clovis site discovered in Kentucky and has one of the rare 'pure' assemblages of Clovis fluted point manufacture known in eastern North American. The Adams site offers a rare unique opportunity to examine the complete sequence of Clovis fluted point manufacture, from procurement of toolstone, a local chert called Ste. Genevieve, through various blank and preform stages, concluding with the fluting and edge grinding on finished points. Adams is part of the Little River Clovis Complex that includes four Clovis workshops (Gramly and

Yahnig 1991; Yahnig 2009). They are: Adams (15CH90), Ezell (15CH483), Boyd-Ledford (15CH230), and Roeder (15CH482), spaced 1-2 km apart in Christian County.

The Little River is a tributary of the Cumberland River that is itself part of the greater Mississippi system. The lithic assemblage at Adams is dominated by bifaces and prismatic blades, and no other eastern North American site demonstrates the importance of blade manufacture like this site. The Clovis fluted points conform in all respects to the specimens that make up the classic Clovis form, and are quite unlike the deeply concave based Vail and Debert points that are quite common in the Northeast region. But a few preforms in the assemblage suggest that wide fluted St. Louis variant fluted points (Perino 1985) were being produced at the Adams site. These bulky points with rounded tips may have been better suited as hafted knives rather than piercing or projectile implements. These St. Louis style points represent another of the Clovis fluted point variants that I have identified (Table. 2.3).

In Tennessee the story is very similar to that of North Carolina, in that the majority of Clovis fluted points are isolated or surface-collected finds which are reported through various state fluted point surveys and some private collectors. (Broster and Norton 1990, 1996a, 1996b). The Carson-Conn-Short site (40BN190) in Benton County (Tables. 2.1; 3.1) is a large camp / workshop made up from a series of partially flooded terrace banks south of the old Tennessee River (Broster and Norton 1993, 2008; Norton and Broster 2009). It was discovered by three avocational archaeologists. Mr H. Carson, Mr G. Conn, and Mr Short, who reported it to the Division of Archaeology, and in 1962 it was examined by Broster and Norton (1993) who reported eight separate localities where artefacts were eroding out the bank by the river. It is a multicomponent assemblage, containing both Clovis and the later Cumberland (but see Gramly 2016). The *in situ* Clovis component yielded over two thousand artefacts representing a blade manufacturing site, including blade cores, blades and tools made on blades, all were produced from the local Fort Payne chert (Stanford *et al.* 2006). The discovery was a first for Tennessee and represents one of the few cases of buried stratified Paleoindian deposits associated with diagnostic artefacts in the entire Southeast region (Goodyear 1999; Broster *et al.* 2013). In respect of their input the site was named after the three individuals who discovered and reported it.

In contrast to the northeastern region, the southeast has a greater number of isolate / surface-collected Clovis points (Tables. 3.2, 3.3), some of which make up my sample (Table. 5.1). But there are more stratified Clovis sites containing Clovis point assemblages that I did not get access too. These are covered in the supporting evidence (Appendix. A).

2.3.3 Region 3: Midcontinent and Great Lakes

In area, this region is about 1,150,000 sq km and includes the states of Wisconsin, Minnesota, Missouri, Illinois, Indiana, Ohio, Michigan, and Iowa. The Great Lakes area in this region includes both glaciated and unglaciated landscapes. The glaciated area contained postglacial lakes and bogs and during the LGM ~18,000 ^{14}C yr BP / 21,500 Cal yr BP; the continental ice sheet covered most of the basins that were to become the Great Lakes. By ~14,000 ^{14}C yr BP / 17,000 Cal yr BP the ice sheets were retreating and tundra-like environments appeared in the north, bordered by boreal forests and mixed deciduous and coniferous forests (Lepper 1999). The animal species living in this region were very similar to those in the rest of the eastern North America. Mastodons probably outnumbered mammoth due to the forests and woodland habitats in the late Pleistocene. It has been suggested that mammoths and mastodons were not contemporaneous in the southwestern Lake Michigan basin, mammoths being replaced by mastodon between ~12,500 and ~11,000 ^{14}C yr BP / 15,000 to 13,000 Cal yr BP, with mastodons becoming extinct in southeastern Wisconsin by ~10,800 ^{14}C yr BP / 12,900 Cal yr BP (Overstreet and Stafford 1997).

Very few fluted-point sites in the Great Lakes have reliable radiocarbon dates (Lepper 1999:370), and the earliest Paleoindian fluted points in the northeastern regions have often been argued to be a post-Clovis form called Gainey. The Gainey site in Michigan had been dated by thermoluminescence which produced dates younger than Clovis (Simons *et al.* 1987) that led to the Gainey fluted point being classed as a post-Clovis variant. In many of the sites in the Great Lakes and Midcontinent region the Gainey form coexists with Clovis, or was originally attributed to being a post-Clovis variant. Geometric morphometric analyses of points from some of these sites with the 'classic' Clovis points from the Southern Plains, show that these points are indistinguishable from the traditional Clovis form (Buchanan *et al.* 2014; Smith *et al.* 2014).

The Paleo Crossing site (33ME274) in Medina County (Tables. 2.1; 3.1), northeastern Ohio (Brose 1994; Eren *et al.* 2004) yielded fluted points that resembled the Gainey type but are now recognised as being Clovis (Boulanger *et al.* 2015). The site was discovered and surface-collected during the early 1990s and along with Clovis fluted points and other tools, there is a large amount of thinning and waste flakes from both manufacture and maintenance. The multicomponent early Paleoindian campsite has a recent reliable ^{14}C date (Table 2.2) making it one of the oldest Paleoindian sites in the Great Lakes area of the midcontinent region (Miller 2013).

The Ready / Lincoln Hills site (11JY46) in Jersey County (Tables. 2.1; 3.3), Illinois (Howard 1988; Morrow 1995; Morrow and Morrow 2002a) contains the full range of Clovis manufacture, from early-stage biface reduction to finished fluted points. Local outcrops of Burlington chert provided nearly 90% of the toolstone used. The fluted points recovered from the site conform closely to the descriptions of the Clovis type (Roosa 1965; Wormington 1957; Haynes 1980a; Howard 1990). The fluted point manufacturing sequence represented at the Ready site provides an alternative model of Clovis point production. Morrow suggests

(1995:177) that the flintknappers at the Ready site were producing late-stage fluted preforms and the main products being transported away were finished points. A suggestion perhaps supported by the relatively low amount of broken final-stage points compared to the amount of other Clovis manufacturing evidence. At present there are no ^{14}C dates available for this site.

In St. Clair County, west-central Illinois, the Bostrom site is a multicomponent habitation campsite. The Clovis component artefact assemblage is dominated by fluted bifaces and points and unifacial scrapers, and was recovered by an archaeological surface survey. Two fluted points from the assemblage, a Clovis point and a Ross County Clovis variant make up my analysis and are part of my surface-collected sample (Table. 3.2). The archaeological context of four features suggests that the site was used primarily for short-term subsistence activities (Tankersley *et al.* 1993; Tankersley 1995).

One other Clovis site from Illinois that is included in my analysis is in fact two sites, the Mueller-Keck Site Complex is made up of the Mueller site (11-S-593) and the Keck site (11-S-1319), both were surface-collected between 1974 and 2003 (Amick and Koldehoff 2005), and are about 1 km apart in St. Clair County (Table. 2.), and represent two of the largest Clovis lithic assemblages in the Midwest. Reinvestigations at these sites suggested that they were functionally distinct settlements. Keck may have served as a hunting camp servicing Mueller, which functioned as a base camp (Morgan *et al.* 2008). As with the Ready site above, there are at present no ^{14}C dates available.

There is another distinctive Clovis fluted point variant that appears in the Great Lakes part of this region called the Ross County Clovis and was first recognised in the 1960s and derives its name from Ross County, Ohio (Prufer and Baby 1963). These points are similar in shape to the waisted Clovis from the southeast, and may represent a continuation of this type.

It is described as having a broader blade than the more traditional Clovis fluted point. A defining characteristic is the presence of wide, shallow thinning flakes on the blade with short, marginal retouch converging from the blade edge. The blade is described as being recurvate (in that it bends backwards) and constricts at the waist; all other Clovis technological characteristics are present (Table. 2.3). Apart from the Great Lakes, these points are reported in lower frequency in northern Alabama, Louisiana, South Carolina, Kentucky, Virginia, and Missouri (Justice 1995:21).

In the midcontinent area of the region, the two states represented are Iowa and Missouri, and are the only two states in the whole region that do not border a Great Lake. Clovis points were found in a cache of twenty whole and fragmentary bifaces in Iowa at the Rummells-Maske site (13CD15) in Cedar County (Tables. 2.1; 3.1), Iowa (Anderson and Tiffany 1972; Morrow and Morrow 1994; Morrow and Morrow 2002b). There is no solid evidence to suggest that this site was either a kill site or campsite, and the cache could represent storage of quality tool-stone and or preforms and biface blanks. The fluted points were made from Burlington chert, like those from the Ready / Lincoln Hills site. These Clovis points have a distinctive style, they have a rounded upper section, an excurvate (a gentle smooth outward curve) blade that constricts towards the base, and some of the points resemble the St. Louis Clovis variant (Perino 1985). Unfortunately there are no ^{14}C dates at present for the Rummells-Maske site; very few Clovis cache sites are dated. The Anzick site in Montana is the only Clovis cache site to have reliable dates at present (Table. 2.2), and the only Clovis cache associated with human skeletal remains (Kilby and Huckell 2013).

The Kimmswick site (23JE2) in Jefferson County, (Tables. 2.1; 3.1) eastern Missouri (Graham *et al.* 1981), has mastodon bones in direct association with Clovis artefacts, but for some reason does not appear in the list of fourteen Clovis sites that had direct evidence of humans hunting extinct megafauna (Grayson and Meltzer 2002). The site produced two Clovis fluted points which were found amongst the remains of a mastodon. One, K-L22-32 (KIM 01), is described as being of a steel-grey chert with minor impact damage; the second, K-H22-83 (KIM 02), is made from olive-green chert and is heavily reworked. Both points display the characteristics consistent with the classic Clovis form, and the KIM 01 specimen is remarkably similar to the type-specimen example (BWD 01) from Blackwater Draw Locality No. 1, New Mexico, and is represented in greater detail in the Southern Plains Region. A third Clovis point, FMNH 205526 (KIM 03), was found with other artefacts and presumably in association with mastodon bones in the 1900s and represents one of the earliest Clovis fluted point discoveries in North America [6]. These artefacts are now in the Field Museum of Natural History, Chicago (Graham *et al.* 1981:1116). No ^{14}C dates exist at present for this site (see Haynes *et al.* 2017); however if the assumption of mammoth and mastodon extinctions in Wisconsin is followed, then Kimmswick would fall well within the Clovis date range (Overstreet and Stafford 1997).

Other stratified Clovis archaeological sites containing Clovis point assemblages that I did not have access to are covered in the supporting information (Appendix. A). There are many Clovis points from an isolate / surface-collected context that make up my comparative sample, some of which I included in my analysis (Tables. 3.2; 5.1).

2.3.4 Region 4: Northern Plains

The northern prairies and plains of North America are mainly in Canada, but due to the position of the continental glaciers in the late Pleistocene and for the purposes of my thesis research, the discussion on this region will focus on the states of Montana, North Dakota,

[6] At present the three earliest recorded points that are Clovis but were not recognised as such are the specimen found within the mastodon bones at Kimmswick Missouri in the early 1900s (Graham et al. 1981), In the 1800s fluted points, now recognised as being Clovis, were recovered within mastodon bones at the Big Bone Lick site in Kentucky (Tankersley 1985), and in 1861 a specimen was recovered in Tarrytown New York which is at present unpublished. However, if the circumstances of the discovery surrounding the Fenn cache in the early 1900s are correct, then these points are also among the earliest Clovis recovered (Frison and Bradley 1999)

South Dakota, Wyoming, Nebraska, and Colorado. The de-glaciated areas in this region were made up of tundra, wetland and shrub habitats rather than prairies. The area made up of prairie/plains in this region is about 1,500,000 sq km. Over 800 fluted points have been reported from the region (Anderson and Faught 1998, Anderson *et al.* 2010), but it is estimated that the vast majority of these points are Folsom and greatly outnumber Clovis (Haynes 2002:55).

The Dent (5WL269) site in Weld County (Tables. 2.1; 3.1), Colorado was first excavated in 1932 (Figgins 1933), which made it the first human-mammoth associated site in North America to be recorded. It therefore should have given its name to the fluted point forms that were found there. As the Clovis point type was not yet recognised as a distinct type from Folsom (Holliday and Anderson 1993), the points were classified as being either Folsomoid or Folsom-like.

After the excavations at Blackwater Draw in New Mexico in the early 1930s, Clovis and Folsom were separated as individual technologies (Cotter 1938). The Dent site had the remains of at least fifteen mammoths, mostly females and their young. There were three Clovis points recovered, but one was heavily reworked and modified, and used as a hafted knife. Unfortunately one of the points was stolen 5WL269-001 (DEN 01) in the 1940s and only good quality cast replicas exist (Brunswig 2007). This is an important argument for the use of making good quality replicas of artefacts. It was not until 1963 that the first ^{14}C dates were made (Agogino 1968a). Further analysis in the 1980s and 1990s (Haynes 1992) produced the most recent reliable ^{14}C dates (Waters and Stafford 2007) [7].

[7] Whilst carrying out my research on the Dent point 5WL269-002, I believed that the damage to the point's tip was made in antiquity, such as impact damage. It was not until I saw an image of the point in Wormington's (1939) 1st edition with the tip intact that I realised the damage must have occurred whilst in the Museum of Natural History, Colorado before the 1949 3rd and 1957 4th editions (Wormington 1939, 1944, 1949,1957)

During my analysis of Clovis points of the Northern Plains and in particular eastern Colorado, I came across other fluted points that resembled one of the Dent specimens 5WL269-002 (DEN 02), from a series of sites and locations from the Kersey Terrace in Weld County (Zier *et al.* 1993) and from the Platte River (Holliday 1987). I include several of these Clovis points from Weld County in my sample analysis (Tables. 3.2; 5.1). The Klein (5WL1368) site in Weld County, Colorado (Table. 3.1), yielded two Clovis points that both resemble the Dent point in form and technology and were described as being made on a reddish chert, source unknown. There was also evidence for mammoth and horse at the site, and the excavations suggest that the artefacts and animal remains may be contemporaneous; however while occurring in general association with the Clovis artefacts, there is no direct evidence for a relationship between the two (Zier *et al*. 1993). There is a widespread occurrence of isolated Clovis points in northeastern Colorado, and in particular the vicinity of the Kersey Terrace gravels on both sides of the South Platte River.

Landowners and collectors, Mr. L. Klein and Mr. M. Fox both collected Clovis fluted points from their farms and around the Weld County area in general (Jepson *et al.* 1994). Mammoth remains in association with Clovis artefacts are also believed to have been recorded from the Kersey area near the South Platte River (Holliday 1987; McFaul *et al.* 1994) and others from the Kersey and Kuner river terraces near Greeley (Haynes *et al.* 1998). A Clovis isolated surface find from Turkey Farm, in Weld County, named the Fox site (5WL1477) after Mr. Fox, is very similar to the Dent and Klein forms.

However, the evidence present at these sites do not provide incontrovertible evidence of human-mammoth relationships (Frison 1991b:39), but do resemble other Clovis sites that do have direct associations, such as the Colby site in Wyoming.

The Colby site (48WA322) in Washakie County (Tables. 2.1; 3.1), northern Wyoming, when discovered in 1973 (Frison and Todd 1986), yielded seven mammoths that were killed and butchered, possibly over an extended period of time. The site also had another distinctive Clovis fluted point variant, the deep concave-based form, similar to the Debert fluted points from the Northeast Region. These forms have a unique basal appearance which displays rounded ears and an overall rounded deep basal concavity design (Figure. 2.2). It has been suggested (Bradley *et al*. 2010:102) that these went through various reworking processes that led to the variability. The flaking on either tips and or bases including refluting could result in a point form that might be mistaken for an original form. Most Clovis points exhibit some evidence of reworking, most commonly resharpening or reworking the base as a result of an impact. It is my belief, however, that the Colby points are an original form and their distinctive basal characteristics are not purely due to reworking, otherwise we would surely see more reworked Clovis points displaying the same characteristics. During the literature review and my analysis of Clovis points throughout North America, I came across very few examples that displayed the same characteristics, and those that did, were from the same region from the Fenn cache (see Frison and Bradley 1999:28). I also suggest that as all four Colby points are very similar, three of the points display the particular basal style, and the other tools present are also associated with the mammoth remains, it is most likely that there was just one event at the site, and was carried out by one Clovis group.

The Sheaman site (48NA304), in Niobrara County (Tables. 2.1; 3.1), is a stratified Clovis campsite in eastern Wyoming and was excavated in the 1970s by the University of Wyoming (Frison and Stanford 1982). A single Clovis fluted point was recovered, and demonstrates a slightly atypical Clovis manufacture technology in that the flutes or channel flakes have been obliterated to some extent by subsequent flaking that led to the point being attributed to the later Goshen point type (Frison 1991c). There is, however, no question that flutes are present, and that the point has been reworked slightly towards the base, possibly to rectify some damage during use, and without the modification and limited flute scars the point would resemble a typical Clovis point; the raw material type is a variety of quartzite. An interesting and puzzling aspect of the site is the age. Clovis occupation is thought to date to 11,220 ± 50 ^{14}C yr BP based on the averaging of the three oldest dates from the Clovis horizon (Haynes *et al.* 2004). The date is outside the current date range of early Clovis sites, and would make it the oldest Clovis site in North America. The previous date for the site was 10,305 ± 15 ^{14}C yr BP, but is also clearly outside the expected date range for Clovis on the opposite end of the scale, and the absolute age of the Sheaman site remains a problem (Waters and Stafford 2013). A more recent evaluation of the site and age of the site supported the later date and concluded that caution should be taken when unquestionably accepting some aspects of the technological evidence as *de facto* cultural markers (Sellet 2015).

Two further Clovis points from southeastern Wyoming are in my analysis (Table. 3.1). They are recorded as coming from the vicinity of the Hell Gap site (48GO305). The Hell Gap site is a multicomponent site that is the type site for the Hell Gap point (Larson *et al.* 2009). Investigations revealed the most complete sequence of Paleoindian cultural remains in the region (Irwin-Williams *et al.* 1975). Within 10 km of the Hell Gap site, remains of mammoth and Clovis lithics were recovered, including the two points, which had started to weather out from buried stream deposits (Irwin-Williams 1975:43). In central Wyoming, the Casper site (48NA304) in Natrona County, another Clovis point was recovered from below the Hell Gap component at the site with Camel remains, but it is uncertain whether they were directly associated (Frison 1974:71).

The Lange-Ferguson site (39SH33), in Shannon County (Tables. 2.1; 3.1) in the White River Badlands of South Dakota, is a mammoth kill site that also has extensive evidence for butchery and bone modification (Hannus 1990). There were two complete Clovis fluted points recovered from the site and one broken base. Both complete points have been reworked, the smaller one extensively, the other has been re-sharpened at least once. Both of these points are very typical of the traditional Clovis basally-fluted point form. The site has been dated to 11,080 ± 40 ^{14}C yr BP from an average of three samples (Table. 2.2) and is regarded as the oldest accepted C^{14} dated Clovis site in North America (Waters and Stafford 2007; but see Haynes *et al.* 2007).

There are several Clovis caches from this region and I will consider the function and interpretation of these sites further in my descriptions of site types below. I will however briefly discuss three of the important Clovis fluted point caches from this region here. The Drake (5LO24) site, in Logan County (Tables. 2.1; 3.1) was discovered whilst ploughing a wheat field in north-central Colorado (Stanford and Jodry 1988) by Mr. O. Drake. There were thirteen Clovis fluted points, some fragments of ivory and a chert hammerstone. There is very little variation in the fluted point forms and all are unused. The damage that some of the points exhibit was post-depositional and possibly was due to the recent ploughing. The Drake cache offers an opportunity to study Clovis fluted points that are in their original condition and do not display any signs of reworking or resharpening. It has been suggested (Stanford and Jodry 1988) that the cache was part of human burial offering rather than storing the points for later use.

The Anzick cache (24PA506) in Park County (Tables. 2.1; 3.1), Montana was discovered in the 1960s by heavy machinery whilst excavating the base of a large escarpment just southeast of a town called Wilsall, and in earlier publications it is called the Wilsall site. Construction workers uncovered a cache of bifaces, fluted points and some human remains in 1968 (Taylor 1969). The lithic artefacts were identified as Clovis and the collection was divided up between the landowner, Mr. M. Anzick, and the other half being split equally among the two workmen. Initial analysis on the human remains suggested that were later depositions and therefore not part of the original Clovis cache. Recently the remains were reinvestigated and became the centre of professional and media attention as it was proclaimed that they were of Clovis age and had implications for the peopling of the Americas through DNA analysis. (Rasmussen *et al.* 2014, 2015; Meltzer 2015; Fiedel 2007; Morrow 2017a), but I will not discuss this argument here. Although it has implications in dating the burial, the site has reliable ^{14}C dates (Table. 2.2), and remains the only cache site to have ^{14}C dates at present (Kilby and Huckell 2014).

Eight Clovis fluted points were recovered from the cache as well as a lot of other lithic artefacts. All stages of Clovis fluted point manufacture were said to be represented (Wilke *et al*. 1991). The majority of the points in the Anzick cache are considered to be Clovis, although there are a couple points which are a straight based Clovis variant, see specimen (88-68-20). The bases on these points are straight, have ground edges, straight sides and the blade has a distinctive triangular appearance. These points have very short channel flakes or flutes, and display well controlled flaking, with the occasional overshot flaking present; which may or may not have been intentional (Eren *et al.* 2014b), and the points appear to be unused.

The Fenn cache (Table. 3.1) was discovered somewhere along the Utah / Wyoming / Idaho state border around 1900, the true nature, and exact location of the discovery remains uncertain, however it has been suggested that the findspot is in Sweetwater County, Wyoming, bordering Utah and Idaho (Lassen 2005). The original finder mounted a lot of the artefacts on a board and displayed them before being tucked away in a basement for many years. They were later sold to a Mr. F. Fenn and there has only been one major intensive study on the cache to date (Frison and Bradley 1999). But the cache has served as a comparative collection for other investigations on Clovis caches (Kilby 2008:92), and good quality epoxy resin casts of the fluted points are available. The collection includes twenty

Clovis fluted points, thirty-four bifaces, and two blades. The twenty points show some degree of variation in form with blade outlines varying from tapering from nearly straight to considerably excurvate. The bases range from nearly straight to deeper concave bases, very similar to the Colby points, there is also an example of the unfluted Clovis form. Some points show signs of use, whereas others are unused like those from the Drake cache.

The variation of the point forms in the assemblage is interesting as some of the largest specimens resemble those from caches in Idaho and Washington, and some are remarkably similar to the Colby point forms. I considered how an assemblage of Clovis fluted points with a range of technological, toolstone, and shape, came to be in a cache already surrounded by mystery. It suggests that these points were not the work of just one flintknapper which is unlike other caches, as discussed above and further below, and the toolstone types appear to have been selected for their appearance and exotic effect. However, in defence of the Fenn assemblage, it is believed to have been found around 1900 (Frison and Bradley 1999); if that were the case, it long predates the Colby material which was not found until 1973 (Frison and Todd 1986), and that the Colby style of point was not known. The first Clovis fluted point was not published until over ten years later (Fowke 1913; Hranicky 2011:11). Although the mystery surrounding the history of the cache remains, the distinctive Clovis technology and the obsidian hydration analysis carried out on some of the points (Frison and Bradley 1999) support the authenticity of the cache (Kilby and Huckell 2014:262). It is, in my opinion, likely that the assemblage was put together from other findspots and reburied as a cache sometime around 1900.

Many isolate / surface-collected occurrences have been recorded in the region, and some of these make up my comparative analysis (Tables. 3.2; 5.1).

2.3.5 Region 5: Southern Plains and Desert Southwest

The Southern Plains is another region with two subregions:-

- the Desert Southwest states of New Mexico, Arizona and parts of northern Mexico
- the Southern Prairie / Plains states of Kansas, Oklahoma and Texas

Texas is included here as a whole area, though much of eastern Texas is covered with woodland similar to the eastern states. The area discussed here covers over 1,600,000 sq km, and over two thousand fluted points have been recorded, with only about one-third being Clovis, Folsom types greatly outnumbering Clovis as in the northern Plains (Anderson and Faught 1998; Anderson *et al.* 2010).

Southern Plains subregion

The Gault (41BL323) site in Bell County is situated in central Texas's Edwards Plateau, and is also where the cherts of the same name are located. The site has been known to archaeologists since 1929 and several official projects and unfortunately many amateur archaeologists and artefact collectors have been active at the site over the years [8]. It is now home to the Gault School of Archaeological Research and run by the Texas State University. Gault is a multicomponent site as well as having good evidence for a pre-Clovis component (Collins and Bradley 2008). No ^{14}C dates are available at present for the pre-Clovis or Clovis levels, but the mean optically stimulated luminescence (OSL) age of the Clovis deposits of 12,900 ± 700 are in accordance with the existing archaeological and geochronological Clovis data from Texas at ~13,600 to 13,000 Cal yr BP (Rodrigues *et al.* 2016).

Gault has a well stratified Clovis component that includes a full Clovis toolkit as well as several complete Clovis fluted points (Tables. 2.1; 3.1). The site has been described as a

[8] There was a period in the 1980s when the Gault site was subjected to a 'pay to dig' operation, where 'relic hunters' were encoraged to basically take whatever they uncovered for just $25 a day (see Hester *et al.* 1992)

quarry and campsite and there is possible evidence for man-made structures, a cobble pavement and hearths that has been interpreted as being some of the earliest evidence for settlement in North America. There are also a number of engraved stones that were discovered at the site (Collins *et al*. 1992) that are almost completely unknown from the Clovis period (Collins 1998). A heavily reworked and damaged Clovis point made of Texas Alibates chert, was recovered in 1998 lying between two of these engraved cobbles (Wernecke and Collins 2011:3).

A Clovis site in Denton County, Texas (Tables. 2.1; 3.1) called Lewisville (41DN72) was excavated in the 1950s by local archaeologists from the Dallas Archaeology Society and revealed several hearths in an occupation area (Crook and Harris 1957, 1958). Associated with these were numerous remains of extinct fauna, including mammoth, Bison, camel, horse, ground sloth and a sabre-toothed cat; whether all these are associated with Clovis activity is not known. Controversy surrounded the site in the 1950s and 1960s when dates for the site were taken from samples of the hearths and were given at 37,000 ^{14}C yr BP (Crook and Harris 1962; Graham and Heizer 1967). The site was shelved until the 1980s when further investigations by D. Stanford and the Smithsonian Institution were able to get a more accurate and realistic date for the site (Table. 2.2) and the original archaeology was authenticated (Stanford 1982, 1983). A single Clovis point was recovered from one of the hearths, Hearth 1, in 1951. The distal end has been shattered and repointed, possibly allowing for the rather rounded blade area. It was suggested that in its original condition it would have been a much larger, longer point and thus resemble the more traditional classic Clovis (Crook and Harris 1957) which is far the most common Clovis fluted point form in this region.

The Miami (41RB1) site in Roberts County (Tables. 2.1; 3.1) Texas, was, as discussed above, one of the earliest Clovis discoveries associated with mammoth (Sellards 1952), and along with the Dent site was not acknowledged as being Clovis until after the excavations at the type site at Blackwater Draw, New Mexico. Miami was excavated in 1937 (Sellards 1938) and later reinvestigated in 1990 (Holliday *et al*. 1994). There were remains of five mammoths, three mature and two juvenile and no other fauna remains. Excavations uncovered three Clovis points and a scraper, the archaeological record being very similar to other sites where a single event occurs. The three fluted points from the Miami site are very similar in style to each other and I would describe them as being classic Clovis (Figure. 2.1). Of the three points in the assemblage, only one is still available for study as the other two were unfortunately stolen, but good quality casts of all three points do exist. This again highlights the importance of casting lithic assemblages, and why quality casting is very important, as it enables study of certain specimens that otherwise would be impossible (Slade 2018).

The Domebo site (34CD50), in Caddo County (Tables. 2.1; 3.1) Oklahoma, is one of many buried sites with mammoth associations in this region (Leonhardy 1966). The site is in the bottom of a gully and the bonebed was disturbed by erosion. The remains of a large adolescent female mammoth were excavated in 1962 and two complete Clovis fluted points and a fragment of a third were found amongst the bones. A fourth Clovis point was later discovered along with a side-scraper and utilised flake washed out downstream. One of the points found among the bones is a classic Clovis fluted point form, and whilst all four points display typical Clovis characteristics they do appear to differ slightly from each other. Whilst carrying out my analysis on these points I recognised similarities in style and form on one of the Domebo points to another point from a site, in the San Pedro Valley, Arizona, discussed below. Developments in accurate dating of fossil remains using accelerator mass spectrometry (AMS) have relied upon the Domebo mammoth assemblage as a key sample (Hofman 1988). The ^{14}C dates produced from other samples (Taylor *et al.* 1996) for the Domebo site are currently some of the most reliable in North America (Table. 2.2).

In 1994 whilst excavating the Folsom-age Cooper Site in northwest Oklahoma (Bement 1999) archaeologists discovered a bison kill and assumed they had found another Folsom site. The Jake Bluff site (34HP60) in Harper County (Tables. 2.1; 3.1) Oklahoma (Bement and Carter 2010), is located on the Beaver River, known elsewhere as the North Canadian River. The site is unique, in that it has both Clovis and Folsom components in contemporaneous stratigraphic and chronological context. Excavations by L. Bement of the Oklahoma State Archaeological Survey and B. Carter of the Oklahoma State University have demonstrated that Jake Bluff's two cultural horizons are distinct, diagnostic, and well preserved (Bement and Carter 2010). The Clovis levels at the site are reliably ^{14}C dated to 10,765 ± 25 (Table. 2.2) that post-dates all other known Clovis kill sites and places Jake Bluff as one of the youngest Clovis-aged sites in North America (Waters and Stafford 2007; Carlson and Bement 2013). The Clovis bison kill included a cow/calf herd of at least twenty-two individuals driven into the arroyo (a dry creek or stream bed that seasonally fills and flows after sufficient rain) to a knickpoint (sharp bend in a gully or arroyo), where the animals were held up and caught in a crush. Four Clovis fluted points were recovered from the site, and all four were found in the bonebed of the arroyo. The points are very similar to the Domebo assemblage in that they are all slightly different to each other in shape but all display typical Clovis point characteristics.

I discovered one of the points (34HP60-1947) recovered from the bonebed was associated with a black bear kill (L. Bement pers. comm. London 2015). The bear remains (*Ursus americanus*), and the point with bear residue (Yost 2007) were found in a paleo-gully, with the bear possibly being drawn to the smell of the bison kill. This is the first documented instance of a Clovis point in direct association with bear in North America (Bement and Carter 2010). Bear remains have been found in some faunal assemblages at Clovis sites elsewhere but not in direct association: Murray Springs, Arizona for example (Haynes and

Huckell 2007:52). A fifth point had been refurbished into a drill and the original shape and size of the original point is unknown and was not included in this study.

An isolated Clovis point from the banks of Bull Creek was recovered from (34BV177) Beaver County (Tables. 2.1; 3.1), Oklahoma, and is in a private collection. The point 34BV177-1 (BUL 01) has traces of mammoth blood residue on the both faces and edges of the point that showed up during use wear analysis (Puseman 2004). This specimen is not fluted on either face but does display all other Clovis technological characteristics. This could be an example of the unfluted Clovis variant. Plainview and Goshen unfluted point forms are present in Oklahoma, but are not associated with mammoth as they are younger than the Clovis fluted points. Although no Clovis kill sites have been identified along Bull Creek, the remains of mammoth, bison, and camel in stream deposits, along with the evidence of residue on this point, suggests the possibility that Clovis-era kill sites may be present, or once existed (Bement *et al.* 2007)

In Kansas, the third state in this subregion, Clovis archaeological sites are rare. A surface assemblage of Clovis lithic artefacts from the Eckles site (14JW4) in Jewell County, north-central Kansas (Holen 2010) can therefore make a significant contribution to our understanding of Clovis lithic procurement, mobility and landscape use in the area. The lithic assemblage is unique in that it contains a complete discarded tool kit and evidence of a newly- produced tool kit [9]. The two assemblages suggest that Eckles was most likely a campsite that was close to a kill site and processing area. There are three nearly complete Clovis points from the Eckles site (Tables. 2.1; 3.1), and all are made on the same toolstone which will be discussed in Chapter 5. Only two of the points were available for study, as the third is in a private collection (Holen 2010; but see Wernick 2015). The points display lithic

[9] Clovis tool kits comprised of many similar, though not identical, components and varied from region to region. And although primarily regarded as weapons and butchery tools, they were also used for foraging and processing small game, fish, and plants. A typical complete Clovis tool kit could include: large bifaces, various fluted points, end scrapers, gravers, blade implements, and non-lithic tools

characteristics that fit well within the known parameters of Clovis technology. The larger of the three points has some impact damage to the distal end and has a deeper basal concavity to the smaller points, which displays a more typical morphology for Clovis fluted points in the region. One of these points was made on a flake (Wernick 2015). Analysis on the points will provide interesting results, in that all three are from an intact context, made on the same toolstone and display contrasting morphological features.

The remainder of Clovis fluted points from Kansas are from isolated finds (Brown and Logan 1987), and I have included some of these in my comparative analysis (Tables. 3.2; 5.1). There are many isolated Clovis points reported from Texas; this may well be down to collection bias, but also due to the fact that Texas has been the subject of several fluted point surveys (see Meltzer 1986; Meltzer and Bever 1995; Bever and Meltzer 2007).

Desert Southwest subregion

Blackwater Draw Locality No. 1 (LA-3324), in Roosevelt County eastern New Mexico (Table. 2.1; 3.1), is located along the banks of a paleobasin formed around ~13,000 ^{14}C yr BP (Hester 1972). Extensive gravel extraction, salvage operations and various test excavations recovered many Clovis points and animal remains (Agogino 1968b; Hester 1972; Katz 1997) that were once in a stratified context, but were later difficult to place into a coherent archaeological record. The site has the remains of eight mammoths in separate bonebeds: two bison kill areas, one containing seven individuals with a Clovis point present and the other with four individuals, and two campsites within the area. At present the dating is problematic in that five ^{14}C dates were reported from the Clovis component (Haynes 1995; Holliday 1997); two on humates are minimum age and do not represent an accurate age of Clovis activity and were rejected, and the other three dates obtained on carbonised plant remains have large standard deviations (Table. 2.2).

In the 1930s, excavations carried out by E.B. Howard in an area called the Mammoth Pit unearthed two fluted points amongst the mammoth bones (Cotter 1937, 1938). These two points became the Clovis type-specimens for Clovis fluted points throughout North America, on the basis of which the Clovis point form was initially defined. Two Clovis forms were also classified (Hester 1972:97), the now traditionally recognised Clovis Type 1 point, and the miniature Clovis Type 2 points. The size of the miniature points may not necessarily discount them from being functioning points, but their function has been the subject of some debate, leading to various suggestions from ritual offerings placed inside mammoth remains (Frison and Bradley 1999:9) to Clovis children's toys (Storck 1988:246; Gramly 1990:64; Dawe 1997), and perhaps just merely produced as small points, using a blade technology (Hranicky 2009a:129). Small Clovis points have been found on several other Clovis-aged sites: Lehner, Arizona; Williamson, Virginia; and Shoop, Pennsylvania.

Another isolated Clovis point I included in my sample analysis was the Bigbee Clovis point, discovered in 1953 [10] on the Bigbee Ranch in Torrance County, New Mexico. The Clovis point was found *in-situ* in association with mammoth bones eroding out of a windblown sand bank. Haynes describes the point as *"In size, outline and workmanship the point compares with Clovis fluted points"* (Haynes 1955:160). There is very little evidence for fluting but basal edge grinding and a basal concavity are synonymous with Clovis technological characteristics. Unfluted Clovis points could be compared with the Plainview unfluted point type, and this specimen compared favourably with a specimen from the Plainview type site in Texas (Sellards *et al*. 1947; Haynes 1955:160). The association of Plainview points and mammoth was not entirely understood, and although mammoth remains had been found at the Plainview site, their association with the bison bonebeds and artefacts was not established (Haynes 1955). It was sometime before the Bigbee point was correctly

[10] This point was the first Clovis point discovered by C.V. Haynes. Jr. (see Haynes 1955)

identified as being an unfluted Clovis point (V. Holliday pers. comm. Arizona State Museum 2014), and therefore I placed it in my unfluted Clovis classification.

The San Pedro River Valley, in southeastern Arizona, has a number of sites that have Clovis fluted points (Tables. 2.1; 3.1) and other stone tools in direct association with the remains of mammoth (Table. 2.5). These are the Lehner (Haury *et al.* 1959), Naco (Haury *et al.* 1953), Escapule (Hemmings and Haynes 1969), Leikem (Johnson and Haynes 1967; Saunders 1980), and Murray Springs sites (Haynes and Huckell 2007). In 1951 E.W. Haury of the Arizona State Museum (ASM) was asked to investigate the discovery of two points that were said to be in association with mammoth bones eroding out of the banks of an arroyo (AZ FF:9.1) in Greenbush Draw, near Naco in Cochise County, Arizona, now Greenbush Creek (Haury *et al.* 1953). In total there were eight Clovis fluted points found amongst mammoth remains. Haury's initial interpretation was that the mammoth remains represented an attack and kill by Clovis hunters on a solitary mammoth. Leaving the points in the carcass could seem wasteful but the task of searching for, and retrieving them may have been regarded as not worthwhile. When originally commenting on why these points were left in the carcass Haury argued *"I do not believe the wounded animal escaped the hunters and died later from its wounds far from the scene of the attack"* (Haury *et al*. 1953:5). The location of the points in the remains of the mammoth suggested that a deliberate attempt to target the spinal cord and brain was carried out, very similar to the occurrence of Clovis points and mammoth remains at the Miami site (Sellards 1938).

Whilst Haury and the ASM were investigating the Naco site in 1952, a rancher, Mr. Lehner, noticed mammoth bones in stratified deposits in a bank of an arroyo and alerted the archaeologists. Over the next few years the mammoth exposure was revisited and then in 1955 the bonebed was exposed by a heavy rainfall and the decision was made to have a proper archaeological investigation. The Lehner site (AZ EE:12.1), Cochise County (Haury *et al*. 1959), is 17 km northwest of Naco. Excavations on the bonebed took place in 1955 and in 1956, and an area containing hearths and butchery activity was excavated. The Lehner site included at least nine mammoths, representing a typical herd group (Lance 1959), and were in direct association with thirteen Clovis points. Two of the points display serious impact damage, one of these ASM-12675 (LEH 05) has a burin-faceted impact fracture that can be caused when the point impacts a particularly thick piece of bone, such as a mammoth scapula, and the foreshaft impacts the basal area and causes the burin fracture (Epstein 1963). In this case the point had previously experienced breakage and had been repaired, rebased and reused. During my research and study of Clovis fluted points from across North America, I came across this breakage characteristic on only one other occasion, an isolated surface-collected Clovis point from the 13MO7 site in Monroe County, Iowa, but other examples surely exist in the archaeological record even though a good many would have also undergone extensive modification and the breakage and may no longer be recognisable.

Another damaged point from Lehner displays a different type of impact fracture, an impact flake scar that travelled down from the tip to almost the mid-point, after the tip had hit probably a large bone such as a rib or scapula. Minor characteristic variations on the thirteen Clovis points exist, some of the points have straight sides, and others have a more convex side. Three small miniature clear quartz unfluted points, ASM-12683, 12678, and 12681 (LEH 01, 02 and 03), were recovered from within the bonebed; it was thought that the raw material influenced the size of these points, rather than prey size. However there was a suggestion that these miniature points may have been buried by the Clovis group when they recovered an unborn foetus of a mammoth whilst butchering the mother (V. Holliday pers. comm. Arizona State Museum 2014).

The two sites at Naco and Lehner differ only in that a single mammoth was present at Naco, with only Clovis points present and no other lithic artefacts, whilst at Lehner there were numerous mammoths, associated stone tools and flakes along with the fluted points. The age of the Clovis kill at Lehner has been placed at 10,950 ± 40 ^{14}C yr BP based on the ^{14}C dates from charcoal samples (Waters and Stafford 2007); there is no reason to doubt that the Naco site would not be of the same age as the other sites in the San Pedro Valley (Haury 1986; Haynes 2007).

The Murray Springs site (AZ EE:8.25) in Cochise County is 17 km to the northwest of Lehner. It was discovered in 1966 (Haynes 2007), and has at least seven activity areas. One, Area 3, has a mammoth skeleton with one complete and two tip fragments of Clovis fluted points and thousands of flakes; another activity locale, Area 4, includes a multiple bison kill where nine more Clovis points were found. The bison skeletons were more disarticulated than the mammoths (Haynes 1976; Hemmings 2007), probably the result of a more complete butchery process. Other animal remains include horse, bear, camel, tapir, and rabbit. A third locality, Area 5, was a campsite, 50 to 100 m away that had two Clovis fluted point bases, unifacial tools and hundreds of flakes, the result of resharpening. An impact flake from the bison kill site refitted to the damaged point found in the campsite, and also a thinning flake found at the campsite refitted to another point in the kill area. A hunting camp, designated Area 6 & Area 7, was later identified (Agenbroard and Huckell 2007) that revealed more Clovis lithics and six more Clovis points, including more intrasite refits. These, along with mammoth bones found at the campsite, linked all the activity areas together. The dates of 10,885 ± 50 ^{14}C yr BP at Murray Springs are contemporaneous with those from the Lehner site and might help link the activity to other San Pedro Clovis sites.

Just 2 km east of the Murray Springs locality is the Escapule site (AZ EE:8.28) on Horsethief Draw, Cochise County. The site was discovered by Mr. L.W. Escapule in the early 1960s and was professionally excavated in 1967 (Hemmings and Haynes 1969). It consisted of a partial skeleton of a mammoth with two Clovis fluted points, ASM-31231 and 31232 (ESC 01, 02), in the rib cage. Both points display impact damage to the tips; the larger of the two points was made on the same grey chalcedony as the Lehner points, and the other on similar chert. Two other sites that could also belong to the same event that seems to be unfolding around an organised mammoth hunt in the San Pedro Valley (Haynes 2007) are the Leikem and Navarrete sites in Cochise County. The Leikem site (AZ FF:9.2) is stratigraphically Clovis in age. It was discovered in 1964 and reported to the University of Arizona. Mammoth bones were exposed in Greenbush Draw 1 km upstream of the Naco Site (Johnson and Haynes 1967), and a complete Clovis point ASM-24127 (LEK 01) was found by a six-year-old girl in the spoil heap from out of the bonebed, but a direct association with the mammoth cannot be determined. The point is very similar to the ones from the Naco site, and in some early literature it was called the Naco II site. The second site was found by Mr. M. Navarrete, who along with his father discovered the Naco Site.

The San Pedro Valley Clovis sites are all within 30 km of each other on tributaries of the San Pedro River that suggest a small band of Clovis hunter-gatherers were in the locality. Based on the amount of meat taken from the eleven bison killed and butchered at Murray Springs, Haynes (1980b) estimated that the Naco and Escapule mammoths may have escaped from the Lehner kill and wandered off to die alone and escaped butchery, the bones of the Naco mammoth show no signs of butchery or disarticulation or evidence of dismemberment. The mammoths at the Murray Springs site may also have escaped from that kill, and were found dead or dying from their wounds and were butchered.

In my analysis I will compare all the points that appear in Murray Springs assemblage, and toolstone types present, to those from the other San Pedro sites, and to see whether the results are similar to other campsite assemblages, and in particular Blackwater Draw. The San Pedro Valley points, along with other Clovis fluted points from Arizona, are reported in the fluted point surveys of the state (Agenbroad 1967; Haynes 2011; Huckell 1982).

An interesting aside to the San Pedro Valley assemblages occurred whilst I was looking at a collection of Paleoindian points in the British Museum in 2006. In the collection, acquired from T.C. Kelly, a colonel in the USAF from Texas, there were several Clovis fluted points (Slade in press c; Slade and Hester in prep) from various locations around North America (also see Slade and Taylor in press). I had recently read a paper reporting two Clovis points from isolated surface finds from Wilcox Playa (AZ-CC-13:1), Cochise County, Arizona (Di Peso 1955). One of the Kelly Clovis points had Wilcox AZ written on it and was made on the same reddish chert as some of the points from San Pedro Valley. I informed B. Huckell and V. Holliday at the ASM of my findings and they both were quite interested and suggested I write a small report on the point (Slade in prep) [11].

Just 250 km south of the Murray Springs site is the site of El Fin del Mundo (Tables. 2.1; 3.1) in the Sonora Desert, Mexico (Sánchez *et al.* 2014). This is the first reported *in-situ* Clovis site in northwestern Mexico, and also contains the first documented evidence of North American predation on the extinct form of elephant known as gomphothere (*Cuvierronious* sp). The site was discovered in 2007 and the excavations revealed a campsite and a kill area, where the remains of two disarticulated juvenile gomphotheres were found (Table. 2.5). Preliminary dates from the site were determined from charcoal from the campsite and are placed at 11,550 ± 60 ^{14}C yr BP (Table. 2.2) as its maximum age. If the dates are correct,

[11] It is interesting to note that the Wilcox Playa, the location of the point found in the collections at the British Museum, is within 100 km of the other San Pedro Clovis sites, made from the same toolstone and displays the same breakage patterns

they put El Fin del Mundo as one of the oldest Clovis sites in North America (Sánchez *et al*. 2014). There are at least seven Clovis fluted points which were recovered, four in direct association with bone concentrations (Sánchez *et al.* 2014). I was fortunate to be given access to some of the originals and have casts of two of the points 46023 (EFM 01) and 63008 (EFM 02), and I include these in my analysis (Tables. 3.1; 5.1).

Without dwelling too much on the debate of how, when, and where the first peoples of North America arrived, by including the dates from the El Fin del Mundo site with the dates from the Aubrey and Gault sites (Table. 2.2), and if the dates from these sites turn out to be reliable, the possibility arises that Clovis may have originated in the southern regions of North America, and if it did not, then Clovis is even older than 11,500 ^{14}C yr BP than the current thinking suggested. There is also an isolated surface find of an obsidian Clovis point that I included in my analysis (Tables. 3.2; 5.1) that comes from Cerro Guaymas, in the Sonora Desert, northern Mexico.

2.3.6 Region. 6: Southwest, Great Basin and Colorado Plateau

This region geographically includes the southeastern corner of Oregon, southeastern California, nearly all of Nevada, small parts of Idaho and Wyoming, northern extremes of Arizona, and much of Utah. The relatively small areas of Oregon, Wyoming, and Idaho that are part of the Great Basin are not discussed here. All of Oregon and Idaho are covered in the Northwest region below. Wyoming and Arizona have been covered above. I have included all of the state of California in this region, although in some studies it is discussed as a separate region (see Haynes 2002:66). I will discuss the Great Basin area first, followed by the Colorado Plateau, and finally the state of California.

The Great Basin area, containing most of Nevada and Utah, is nearly 500,000 sq km, and over two hundred fluted points are known, most of which are resemble Clovis rather than

Folsom, or later (Anderson and Faught 1998; Anderson *et al*. 2010). The archaeological record for this region is almost entirely made up of surface finds (Beck and Jones 1997). During the early Paleoindian period in the Great Basin, several different point technologies existed, and one of these is the stemmed point. It has been argued that these stemmed points, first discovered in the Mojave Desert (Campbell *et al.* 1937) in the 1930s, appear very early in the archaeological record (Bryan and Tuohy 1999). In their view stemmed points date to at least the time of Clovis, the Smith Creek site in White Pine County in eastern Nevada possibly providing the evidence for this, but problems with dates and site interpretation exist (Bryan 1979, 1988). Basgall and Hall (1991) suggested that that fluted points and stemmed points were used by two different cultural groups, and Beck and Jones (1997) reported that stemmed point dates are younger than 10,900 ^{14}C yr BP, which suggested there could have been an overlap with the fluted point tradition; the stemmed points appearing later than the earliest Clovis and would have coexisted only briefly. Among the thirty-five genera of mammals that became extinct in North America during the Late Pleistocene, sixteen are known from the Great Basin (Grayson 1993).

Clovis points do occur in Nevada, but none have ever been found in a well-stratified, well-dated context, and none in association with extinct megafauna. A number of isolated surface finds have been found in Nevada but even these are extremely rare.

I have two specimens that I include in my analysis from Utah in the Great Basin area (Tables. 3.3; 5.1). An obsidian point found in the Blackwater Draw site in New Mexico (BWD 25) has been traced to the Wild Horse Canyon source in Beaver County Utah. The other point used in my analysis from Utah (Tables. 3.2; 5.1; Appendix. C) is a large obsidian point from the Dugway Proving Ground military base in Tooele County, in the western Utah desert (DPG 01). It was found in 1986 by an infantryman during exercises, and is now in a private collection. I was fortunate enough to get a copy of the cast while it was being researched in the Smithsonian Institution (Slade 2018). D. Stanford remarked that *"The point is an excellent example of Clovis flintknapping strategy, showing remnants of 'outré passé' overshot flaking"* (D. Stanford pers. comm. Smithsonian Institution Washington DC 2014). It was found in two pieces, which were able to be perfectly refitted. One of the interesting characteristics of this point was the fluting, covering half the point on one face and over half the point on the other. On average a Clovis flute covers about one third of the point and is narrower. The raw material is a variety of obsidian, at present the source or variety is not known.

The Colorado Plateau area is situated just east and south of the Great Basin, and about twice as many fluted points have been found in the plateau as in the basin area (Copeland and Fike 1988). Folsom points outnumber Clovis points by about three to two. No fluted points from either period have been directly dated as yet, and there are no fluted point occurrences have been found in direct association with mammoth or any other extinct megafaunal remains dating to the Clovis-era (Haynes 2002).

The third area in this region is California, the state is just over 400,000 sq km, and some archaeologists treat this state as a separate division, but for my purposes I include it in this section. Fluted points are much more abundant in California than any other technological culture supposedly older, but it is still very poorly-studied and understood. As in the Great Basin area, as well as other regions in North America, many fluted points are in private collections, and the publicly accessible collections in museums, and the few published studies do not provide an accurate picture of California's Clovis data, although these issues are being addressed (see Prasciunas 2011).

Borax Lake (CA-LAK-36) Lake County in the North Coast mountain ranges is another site rich in surface finds of Clovis fluted points (Tables. 2.1; 3.1). These points were originally described as being a crude type of Folsom point (Harrington 1948), the modern interpretation is that they are more in the style of Clovis. The Borax Lake assemblage includes stemmed points and crescent blades, as well as several fluted point forms including a concave-based unfluted point, which led Harrison to originally suggest they were 'Folsomoid', he was unable to show any clear separation in time between his Folsomoid and Folsom points from Borax Lake and other sites in the Middle Central California area, and classified them as a crude Folsom point form. After reassessment of the material, three separate occupations were identified with the fluted and unfluted concave-based points being attributed to a far western pre-Folsom Clovis-aged variant (Meighan and Haynes 1970), and it is now accepted that the fluted and unfluted point forms are a western Clovis fluted point [12], the crescents also being contemporaneous with the points, whereas the stemmed points belong to a later period. Reliable ^{14}C dating is not possible at some of the Borax Lake localities due to the lack of a strict provenance for the charcoal samples. A series of obsidian hydration (OH) readings were carried out on chips of the same raw material that the points were made from. The results of the OH and the typological analysis of the lithic assemblage, suggest that the Borax Lake material is Clovis, and places the fluted points firmly in the Clovis era (Clark 1964). This was one of the most important findings in the reassessment of the site, as it puts back the early settlement of the northern Californian coast (Meighan and Haynes 1970).

I used several of the Borax Lake fluted points in my analysis as I had access to good quality epoxy resin casts during my data collection visits to the Smithsonian Institution. The fluted points are made on a variety of obsidian, and only the basal fragments are present. If the Clovis levels at the site were being used as a campsite, then this is what I'd expect to find in the archaeological record. The damaged fluted points would have been removed from the

[12] This term is purely geographical and should not be confused with the 'Western Clovis' types that I alluded to above. This is exactly how confusing and complicated the current ambiguous Clovis point typology is

foreshaft by snapping the point off at the hafting point, the basal fragment after being tapped out of the shaft or socket, would then have been discarded. The remainder of the point could then be rebased and inserted in the foreshaft to be reused (R. Patten and T. Baker. pers. comm. Denver 2010, 2011). This activity is replicated at other Clovis campsites across North America, and it is my belief this is why other sites display a high percentage of basal sections, *e.g.* Mockingbird Gap, New Mexico (Holliday *et al.* 2009). Interestingly, several of the bases that are made from obsidian show scratches and abrasions that are similar to those from the Dietz and Hoyt sites in Oregon. The flute scratches are evidence of hafting, where the scratches were deliberately made to aid and facilitate the binding of the material (Slade 2016, in press a). This evidence is almost exclusive to obsidian specimens, but there is at least one occurrence on a different raw material (Rondeau and Temple 2010).

No Clovis points in California have been radiocarbon dated, OH results on various specimens do not contradict an estimate of 11,000 to 12,000 yrs (Clark 1964), and the spatial association of fluted point occurrences with the shorelines of pluvial lakes may be evidence for preferential foraging subsistence strategies along marshy lake edges at a time when the lakes were shrinking (Moratto 1984). Megafaunal remains have been discovered near fluted points in California, but none in direct association. Some other noteworthy Clovis and Clovis-aged sites that occur in these three areas are reported in the supporting information section (Appendix. A).

2.3.7 Region 7: Northwest

This region includes the states of Idaho, Oregon and Washington and is just over 630,000 sq km in area. The majority of the known fluted points from this region are mainly Clovis except from Idaho where Folsom outnumber Clovis about two to one (Anderson and Faught 1998; Anderson *et al*. 2010). The paleoenvironment from west to east contained the ranges and valleys of the Pacific coast; including a submerged continental shelf, inland ranges and plateau, a small region of the Great Basin, and the ranges on the western Rocky Mountains.

Apart from a few sites on the margins of the Great Basin in the east of this region, very few Clovis-era localities have been discovered that offer any solid evidence of occupation on the Pacific Northwest (Erlandson and Moss 1996). The few sites that have fluted points from the Pacific coast areas of California, Oregon, and Washington are all undated. Erlandson and Moss (1996) suggest that the southern localities of the Pacific coast were occupied during the Clovis-era, through the evidence of Clovis points from inland sites, such as Borax Lake in northern California and East Wenatchee in Washington. Dated sites with buried, stratified deposits are extremely rare in this region. Two Clovis caches that are among the exception are the East Wenatchee site in Washington, the other is the Simon site, Idaho.

The Simon site (10CM7), in Camas County (Tables. 2.1; 3.1) Idaho, was discovered in 1961 by Mr. W.D. Simon, the landowner. The cache consisted of thirty-three Clovis tools representing the stages of Clovis biface reduction (Butler 1963). Five complete Clovis fluted points in the assemblage were made on non-local cherts, and three of the early stage bifaces were made on quartz crystal, but perhaps surprisingly obsidian was not present. The raw materials chosen to produce these tools were the most diverse of any Clovis cache in North America. Nineteen different chert types were used and only five occur more than once (Butler 1963; Woods and Titmus 1985). I was able to use the finished Simon Clovis points in my sample from access to good quality epoxy resin casts. During my observations of the points, I noticed that at least one of the points resembled one of the Anzick Clovis points from the cache in Montana (88-68-20) and have similar morphological features. The shape of the point from the Anzick site led some researchers to describe these as being similar to

Clovis and were classified as a Clovis variant, the Anzick Clovis (Perino 1985:18), as discussed earlier, I classified these as being a straight based Clovis fluted point.

The Dietz site (35LK1529) in Lake County (Tables. 2.1; 3.1) Oregon is the largest Clovis site in the Pacific Northwest. The site has yielded over one hundred tools and a great deal of flakes and other lithic debitage, the assemblage is almost entirely made on obsidian. J. Fagan and J. Willig carried out excavations at the site and adjacent areas in the early 1980s (Willig 1984). The initial assessment of the artefact assemblage was inconsistent with use of the site being a kill, campsite or a quarry site (Fagan 1988), and geoarchaeological data support this by revealing that during the Clovis occupation the site was a sparsely vegetated, seasonal playa (an area of flat, dried-up land) that was unlikely to have supported large herds of game animals. The Dietz site was however situated on the edge of a major corridor linking productive ecosystems in the adjoining basins, and Clovis foragers appeared to have camped at Dietz, repeatedly whilst travelling between these basins (Pinson 2011). A Clovis fluted point from near to the Dietz site discovered in the 1950s by Mr. F and Mrs. A Estergreen, showed the same abrasive scratch marks on the channel flakes and basal area as California obsidian points. A ^{14}C date on charcoal from beneath the points from the Dietz Basin lake deposits provided a minimum date which fits within the Clovis date range; ~11,000 ^{14}C yr BP (Pinson 2008, 2011).

In the same area close to the Dietz site another probable Clovis campsite was perhaps part of the same locality in Clovis times. The Hoyt site in Lake County (Tables. 2.1; 3.1) produced Clovis fluted points that had traces of tree resin (amber) adhering to some scratches on the channel flakes similar to those mentioned above (Rondeau 2009a; Slade in press a). The Hoyt points were made on unidentified black opaque obsidian, and two of the Clovis points that were surface-collected at the site and both fluted points will be part of my sample analysis from this region. One of the points was the first documented Clovis fluted point to have its original hafting adhesive preserved on the surface of the point (Tankersley 1994b). The scratches on the channel flakes are quite common on Clovis points made from obsidian from the far west (Wormington 1957:61; Frison 1991a:44; Slade in press a), one of the best examples being an obsidian point from the Fenn Cache, specimen # 107 (Frison and Bradley 1999:19).

The Richey-Roberts site (45DO432), now known as the East Wenatchee cache, is in Douglas County, Washington (Tables. 2.1; 3.1). It was discovered by a workman digging a pipeline in 1987 (Gramly 1993), and was at the time described as being of the most spectacular archaeological discoveries in North America. Until the East Wenatchee discovery, very little was known about Clovis in the northwest. The site's assemblage is famous for its very large Clovis fluted points. Up until this discovery no Clovis fluted points had been known to have been this size (Appendix. C). I was able to look at good quality epoxy resin casts of these points, and will use them in my analysis as part of my main sample. The East Wenatchee site had been indirectly ^{14}C dated to 11,125 ± 130 from some charcoal found in volcanic ash below the artefacts, but has been reassigned a data of ca 11,600 ± 50 ^{14}C yr BP / 13,410-13,710 Cal yr BP on the reassessment of the Glacier Peak Ash and the assumption that the artefacts are contemporaneous (Waters and Stanford 2013) and see (Table. 2.2).

An isolated surface Clovis point from Washington, 10 km from the East Wenatchee site, came to light after the owners read an article in National Geographic on the cache and was interested in comparing their discovery with those from the East Wenatchee assemblage (Table. 2.1). The point was discovered in 1987 on a high plateau called Badger Mountain in Douglas County and is also known as the 'Rutz' Clovis point. At nearly 25 cm in length, it is the longest Clovis fluted point recorded (Gramly 1993:51). The fluted point went up for auction in 2013 and sold for over $270,000 to a private collector in Texas, I was very fortunate to get a good quality epoxy resin cast of the point (Slade 2018), and I have therefore included this in my analysis (Tables. 3.1; 5.1).

There are instances of isolated surface-collected Clovis points from this region, in particular Idaho and Oregon (Reid *et al.* 2014) and I have included several in my analysis (Tables. 3.2; 5.1) and a few Clovis sites have been recovered archaeologically (Appendix. A).

2.4 Clovis site types

Clovis sites primarily fall into one of four main classes; campsites, kill sites, caches, and quarries or workshops, although for the purpose of my variability analysis, I have included isolates / surface-collected finds. In many areas within the seven regions there are no Clovis assemblages that have been reported from archaeological excavation. In those circumstances, we are left with Clovis point occurrences represented by isolated surface finds. These provide valuable information in mapping out spatial distribution of Clovis groups across the landscape, and can also indicate lithic raw material movement and sourcing. Each of the site types represents a particular behaviour and therefore stands to contribute different and supplementary information in regards to our understanding of Clovis adaptations in North America. These site classifications will be covered briefly below and in some cases the site types may be sub-divided (Table. 2.4).

Single component Clovis sites are represented by one archaeological cultural assemblage present, such as the Adams site in Kentucky, which is classified as a quarry / workshop (Sanders 1988) or the mammoth kill site at Lehner in Arizona (Haury *et al.* 1959). Clovis multicomponent sites contain several Paleoindian or later components as well as Clovis, these sites are normally campsites such as Blackwater Draw in New Mexico (Hester 1972), where there are Clovis, Folsom, Agate Basin, and Plainview assemblages present in the archaeological record.

SITE TYPE	Northeast	Middle-Atlantic & Southeast	Midcontinent & Great Lakes	Northern Plains	Southern Plains & Desert Southwest	Southwest, Great Basin, & California	Northwest
Camp: Processing Base	 ✓ ✓	 ✓ ✓	 ✓ ✓	 ✓	 ✓ ✓	 ✓ ✓	 ✓
Kill Kill / Camp	✓ ✓	 ✓	✓	✓ ✓	✓ ✓		
Quarry: Workshop Procurement	 ✓ ✓	 ✓ ✓	 ✓ ✓		 ✓ ✓		
Cache	✓ [1]		✓	✓	✓		✓
Isolates Surface	 ✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓

[1] The Lamb site in New York represents the only evidence for a cache in the Northeast region, and the only cache to be found in a campsite in North America (Kilby and Huckell 2013)

Table. 2.4 Clovis site types and their distribution by region in North America

2.4.1 Clovis kill sites

Kill sites are locations where the selected prey were killed, or scavenged, and butchered (Table. 2.5). Fully processing an animal carcass was a procedure that was likely to take place across more than one area of the site, Murray Springs in Arizona for example (Haynes and Huckell 2007), where initial butchering may have taken place at the location of the carcass, with the resulting meat being transported to another site for processing (see Fisher 1984). In many cases the kill site is close to the campsite and associated with it. However, in this section I refer only to the original location of the kill, as closely as possible.

Kill sites are quite often located around water sources, which would have attracted both human and the desired prey. The site at Blackwater Draw (Hester 1972) is a good example of this as the site has both killing and butchery evidence, as well as campsite activity areas.

Grayson and Meltzer (2002) reviewed Clovis-aged sites that had supposed evidence for humans killing extinct fauna, the so called megafauna overkill hypothesis originally proposed by Martin (1973; but see Grayson and Meltzer 2003; Surovell *et al.* 2005, 2016; Firestone *et al.* 2007; Kelly and Prasciunas 2007; Surovell and Waguespack 2016) or at least remains of megafauna in direct association with diagnostic Clovis artefacts. They argue that of the seventy-six sites, only fourteen stood up under their review and can be considered as Clovis kills. Of these fourteen, twelve are mammoth and the other two are mastodon. After my observations and a review of their paper (Grayson and Meltzer 2015) and a more recent one (Haynes and Huckell 2016), I added to this list three sites with clear extinct bison hunting evidence: Blackwater Draw, New Mexico; Murray Springs, Arizona; and the Jake Bluff site in Oklahoma. I also added the gomphothere kill / butchery site at El Fin del Mundo, Sonora, Mexico, and several more mammoth and mastodon sites that might be of Clovis age, and have Clovis association (Table. 2.5). There is also evidence of a possible Clovis-age bison kill at Wenas Creek in Washington (Lubinski 2016) and has possible associated artefacts (Lubinski *et al.* 2007). And in Arizona there are mastodon remains that date to the Clovis age, but which have no associated artefacts. The Billings mastodon is in Santa Cruz County, southern Arizona was discovered in 1985 (Haynes *et al.* 2016). In Alberta, there is good evidence for horse butchery, at Wally's Beach (Kooyman *et al.* 2006, 2012), as well as possible camel association (see Appendix. A).

The kill site lithic assemblages typically contain an array of tools as well as the fluted points, such as unifacial and bifacial cutting tools, flakes and blades, as well as the flake debitage resulting from re-sharpening. The Clovis points from kill sites are often fragmented or damaged and display impact damage, and some were discarded due to limited usefulness, especially if there was an ample supply of fresh toolstone available. Complete points may not have been recovered from the carcass, through lack of access or deliberately through choice, like at the Lehner site also in Arizona (|Haury *et al.* 1959); or otherwise lost when the wounded individual wandered off and died elsewhere such as in the example at the Naco, Arizona (Haury *et al.* 1953). The point might also have fallen out by its own accord whilst the creature wandered off, this also might explain the large quantity of isolates recorded as complete, slightly damaged fluted Clovis points found on the surface.

SITE	**TAXA AND MNI**	**CLOVIS ASSOCIATION AND OBSERVATIONS**	**DATE ^{14}C yr BP**	**PRIMARY SOURCES**
Big Bone Lick, KY [1]	Mastodon, MNI = n/a	Clovis points, dismissed to be in direct association with bones	10,600 ± 250	Tankersley (1985) Tankersley *et al.* (2009)
Blackwater Draw, NM	Mammoth; MNI = 8 Bison; MNI = 1	Clovis points and other lithics in direct association with mammoth and probable bison	11,300 ± 235	Hester (1972) Holliday (1997)
Colby, WY	Mastodon; MNI = 7	Clovis point variant in direct association with mastodon	10,870 ± 20	Frison and Todd (1994) Brunswig (2007)
Dent, CO	Mammoth; MNI = 15	Clovis points in direct association with mammoth	10,990 ± 25	Figgins (1933)
Domebo, OK	Mammoth; MNI = 1	Clovis points and other lithics in direct association with mammoth	10,960 ± 30	Leonhardy (1966)
El Fin del Mundo, Sonora, [2]	Gomphothere; MNI = 2	Clovis points and other lithics in direct association with gomphothere	11,550 ± 60	Sánchez *et al.* (2014)
Escapule, AZ	Mammoth; MNI = 1	Clovis points in association with mammoth	No date but contemporary with Lehner.	Hemmings and Haynes (1969)
Hebior, WI	Mammoth; MNI = 1	Clovis artefacts, no points in association with mammoth	13,440 13,510	Fisher (1996) Overstreet & Kolb (2003)
Jake Bluff, OK [3]	Bison; MNI = 22 Bear; MNI = 1	Clovis points and other lithics in direct association with bison and bear	10,765 ± 25	Bement and Carter (2010)
Kimmswick, MO	Mastodon; MNI = 2	Clovis points in direct association with mastodon	~11,000 (typologically dated)	Graham *et al.* (1981)
Lange-Ferguson, SD	Mammoth; MNI = 2	Clovis points in clear association with mammoth	11,080 ± 40	Hannus (1989)
Lehner, AZ	Mammoth; MNI = 13	Clovis points and other lithics	10,950 ± 40	Haury *et al.* (1959)
Leikem, AZ[3]	Mammoth; MNI = 2	Clovis points in probable association with mammoth	No date but contemporary with Lehner.	Johnson and Haynes (1967) Saunders (1980)
Lewisville, TX[3]	Mammoth; MNI = 1	Clovis point in probable association with mammoth	~11,000 A redated sample of charcoal gave dates	Crook and Harris (1958, 1962)
Lubbock Lake, TX	Mammoth; MNI = 2	Clovis lithics in clear association with mammoth	11,100 ± 60	Johnson (1987)
Manis, WA	Mastodon, MNI = 1	Pre-Clovis or Clovis bone point in direct association with mastodon	11,960 ± 17	Haynes and Huckell (2016)
Miami, TX	Mammoth; MNI = 5	Clovis points in direct association with mammoth	11,000 ± 400	Sellards (1938) Holliday *et al.* (1994)
Murray Springs, AZ	Mammoth; MNI = 2 Bison; MNI = 11	Clovis points in direct association with mammoth and bison	10,885 ± 50	Haynes and Huckell (2007)
Naco, AZ	Mammoth; MNI = 1	Clovis points in direct association with mammoth	No date but contemporary with Lehner.	Haury *et al.* (1953)

Navarette, AZ	Mammoth, MNI = 1	Clovis points in probable association with mammoth	No date but contemporary with Lehner.	Johnson and Haynes (1969) Saunders (1980)
Pleasant Lake, MI	Mastodon; MNI = 1	No artefacts found, but has butchery evidence	10,395 ± 100	Fisher (1984)
Sloth Hole, FL[3]	Mastodon, MIN = 1 Giant Beaver MNI = 1	Clovis point variants, other lithics and bone tools in clear association with mastodon and beaver	11,050 ± 50	Hemmings (2005) Webb (2006)
Union Pacific Mammoth, WY[1]	Mammoth, MNI = 1	Lithics typical of Clovis but non-diagnostic in clear association with mammoth	11,280 ± 350	Haynes *et al.* (2013)
Wally's Beach, Alberta, Canada[2]	Horse; MNI = 7 Camel; MNI = 1	Clovis points and other lithics associated with remains of horse and camel. The site represents the first horse kill site in North America	10,980 ± 80	Kooyman *et al.* (2006, 2012)

[1] Sites rejected by Grayson and Meltzer after reinvestigations and a review of their 2002 paper (Grayson and Meltzer (2015) but included here
[2] Sites added by Grayson and Meltzer after their review in 2015
[3] Site added through my own observation and interpretation during my review that could be considered

Table. 2.5 Sites that have extinct megafauna remains with Clovis association. Sites listed in bold represent assemblages of Clovis points that are part of my complete sample. Modified from Grayson and Meltzer (2002,2015)

2.4.2 Campsites

Campsites are locations where Clovis groups settled for a short period, perhaps more than once, and sometimes seasonally, to carry out activities in preparation for future resource forays. As mentioned above, campsites are often located adjacent or close to, kill sites, and are also present at quarries. The activities carried out at campsites and the resulting artefact assemblages are quite distinct from the kill site evidence. Murray Springs, Arizona (Haynes and Huckell 2007) has good archaeological evidence for both of these activities and in well stratified separate areas. The impact flake from the kill site that refitted back on to the original point at the campsite is an example of the correlation between areas at a particular site. Archaeologically campsites are rarer, partly due to the faunal components of the well-preserved kill sites, such as at Murray Springs, and Lehner, etc; have drawn more attention to them, but also because the kill sites are commonly discovered on hill tops and stable ridges, whereas campsites are more likely to be poorly preserved and, or, obscured by later occupations. Later groups at these sites may 'scavenge' raw materials from pre-existing campsites accessible from the surface, reducing the amount of diagnostic artefacts from the archaeological record. Campsites have maintenance areas, where the fluted points and other tools are attended to, these areas typically include point fragments discarded after removal from the shafts before or during refurbishment of new points. Basal sections are removed and discarded as these are the least likely to be modified, although in some cases they can be reused as fluted drills (see Hranicky 2009a:285), the fluted base sections provide a valuable record of the presence of Clovis points and their variability. The Californian campsites such as Borax Lake are a good example of this.

I split campsites up into two main classes: base camps or habitation localities, and food-procurement sites. A base camp generally displays tools and debris associated for a wide range of maintenance tasks, whereas a food-procurement camp exhibits tools associated with activities associated with post-butchery and food preparation (Tankersley 1998b).

2.4.3 Quarry / Workshop sites

Clovis quarry sites, sometimes referred to as source camps or workshops, are localities where lithic raw materials were collected and extracted for toolstone for use in the production of Clovis points and other tools and initially reduced down for transport. It is clear, however, from the range of raw material types present in Clovis assemblages from other site types, Clovis groups procured good quality toolstone from a number of geological sources. The Adams site, Kentucky (Sanders 1990); Thunderbird, Virginia (Gardener *et al*. 1974); and the Yellow Hawk site, Texas (Mallouf 1989), are all good examples, and these quarry sites all have at least one example of a Clovis point made on the toolstone present at the site. Typical artefacts at quarries or source camps, tend to be early-stage reduction bifaces and preforms of the local toolstone, or discarded artefacts at the end of their usefulness from other distant raw material source areas. The quarry sites provide good evidence for the initial stages of reduction of lithic forms, such as early stage fluted points, whereas the kill and campsites provide evidence of artefacts near the end of their usefulness and were lost or discarded. What none of these site types regularly show, though, are the complete, unmodified and finished points that were carried away from the sites when the groups moved on. Isolated surface finds do however provide this resource and are one of the reasons I included these in my site type section below and in my sample analysis.

2.4.4 Clovis caches

Since the Sailor-Helton, Kansas, discovery (Helton 1957) Clovis caches have been reported throughout much of North America (see Frison 1991a; Kilby 2008; Kilby and Huckell 2013; Huckell and Kilby 2014a). I included most of the well-known caches in my Clovis regional overview above, and those caches that include Clovis fluted points are included in my sample analysis. Apart from the fluted points, Clovis caches consist of bifaces, flakes, cores, bone and ivory rods and occasionally human remains. In the literature, the term cache has been used in reference to a particular class of assemblage or features characterised by these assemblages. I use the definition of a cache by Kilby and Huckell (2013:257), where *"Collections of artefacts that were intentionally set aside in the past as opposed to discarded, or lost"*. Archaeological evidence for caches exist in the recovery of a assemblage of points from deliberate burial in shallow pits, whereas discarded or lost points would be surface-collected. A Clovis cache is an assemblage, feature, or site that can be attributed to Clovis by the diagnostic artefacts recovered; Clovis fluted points, bifaces and preforms, and blades, caches also represent a unique type of Clovis site.

Regionally Clovis caches are mainly found in the Northwest, Southern and Northern plains, Midcontinent and the Great Lakes. None are reported from the Southwest, Southeast or Northeast regions (see Gramly 1988b for a possible exception), and it looks like the distributions of the caches are concentrated along an arc from the Northwest through the Rocky Mountains to the Southern Plains and south-central North America. Cache sites can fill a gap in the archaeological record of Clovis lithic technology, between the production of the points at quarries and loss or discard at kill sites, campsites and isolated locations (Kilby and Huckell 2014).

2.4.5 Isolates and surface-collected Clovis points

Clovis isolated surface-collected finds are an important resource for the study of Clovis points, as they can be significant in highlighting mobility and long distance movement of lithic materials (Holen 2004). Examples of Clovis point findspots, characteristics and other metric data can be found on the Paleoindian Database of the Americas (PIDBA) which is constantly being updated (Anderson and Faught 1998; Anderson *et al.* 2010; Anderson and Miller 2017), by accessing the various Clovis fluted point surveys across individual states (Perkinson 1971, 1973; Bever and Meltzer 2007; Haynes 2011), the Paleoindian fluted point type distribution reports from states and /or regions (*e.g.* Fitting 1965; Faught 2006; Loebel 2007), and the many various isolated point occurrences reported in journals and the proceedings from state archaeological societies. The problems associated with Clovis points from isolated surface locales are that they are extremely difficult if not impossible to date, and also levels of doubt can exist in the accuracy or legitimacy of the discovery. However, these points do provide some level of typological comparative database and indication of raw material use (see Palacios-Fest and Holliday 2017). In my sample (Tables. 3.1; 3.3; 5.1) I have included many isolated point specimens, as they not only increase my sample size, but also added to the overall distribution of Clovis fluted points, the regional variability of Clovis, and the raw material type and movement of particular toolstone types.

2.5 Summary and discussion

In my overview of Clovis and Clovis-aged sites, I have attempted to list by region what I believe are the most significant Clovis fluted point sites (Table. 2.1) in the contiguous United States, and provide a comprehensive overview of Clovis and Clovis variant point types and their occurrences. The Clovis sites that are not directly related to my analysis, but are still important in understanding Clovis, are discussed in supporting information (Appendix. A). Where possible, I have tried to give these points the best provenance I could, the most recent and reliable radiocarbon dates available (Table. 2.2) and the particular points characteristics and current typological definition where possible, the majority of which I will use in my sample analysis (Tables. 3.1; 5.1).

My overview highlighted how variable Clovis, and in particular the fluted points are, which will be discussed in depth in the following chapters, and how difficult it is to define Clovis as a single point type across North America. I have stated in a previous study of Clovis that *"Clovis was in a constant transitional phase and maybe should not have been assigned its own definition"* (Slade 2010). Finally, I decided to drop the term 'projectile' when describing Clovis fluted points. I don't believe all Clovis points were used as projectiles. Many were actually used as hafted knives, or hand held butchery tools, others as thrusting weapons. In a few cases there is direct evidence for a projectile point, such as the sites in Arizona (Haury *et al* 1953, 1959). There is now evidence that some Clovis points were used to strip back vegetation, and used as a general purpose tool (Logan 2013). This however is not a new theory, it was suggested back in the 1980s by Lepper whilst conducting his PhD research on fluted points in the collections from Ohio (Lepper 1983, 1984), where he found that between 43% and 45% of Clovis points exhibited evidence that they had been used for purposes other than being a projectile. There is also a reference from the 1930s when H.

Shetrone, the curator of archaeology at the Ohio Historical Society that argued that these points would have served admirably as knife blades and were put to multiple uses (Shetrone 1936).

Chapter 3

Methods: samples, site selection criterion, and methodologies

3.1 Aims and objectives

The focus of this research is the phenomenon of Clovis fluted point variability through the variation in their basal morphology and whether it is influenced by lithic raw material selection. I chose the basal-concavity of the points as it is this section of the point that demonstrates the most variation. My focus then takes on a wider analysis and discussion of regional variation in Clovis fluted point assemblages in North America. Over a period of years researching Clovis points, I noticed that although all the points vary considerably in technology and morphology, they share many attributes, the most diagnostic of which are in the fluting, and the flute scars. These are the remnants of the flakes removed from the base that formed the flute. I also recognised that it was in the basal sections that the most variability occurs (Slade 2010).

Basal concavity analysis of Clovis points can go some way in identifying the variability within the points on a regional scale. Where there are just basal sections of the point present in an assemblage, *e.g.* Borax Lake in California (Meighan and Haynes, 1970), the bases can be included in this analysis, when they are often overlooked or left out of other studies.

In accordance with my research questions set out in Chapter 1, I will revisit my caliper-based metric analysis (Slade 2010 and see Appendix. C), and use a geometric morphometric (GM) analysis to study the shape of the basal section variation generated by superimposed landmarks (Slice 2007, 2010), and then explore the patterns in the data using principal component analysis (PCA). While attempting to see how basal point morphology interacted with regional geographies, I used Clovis points in three samples from what I believe is a good regional representation across North America.

3.2 The samples

The three samples which will be used in my analysis testing whether there is a regional basal variability within Clovis points are: samples 1) and 2) that will provide the points used in my main analysis; and sample 3) which will provide valuable additional results by using point illustrations from published material of important Clovis point assemblages that I was not able to get access to for one reason or another.

For this analysis I will carry out caliper-based shape analysis of the basal sections of Clovis points from these three samples that will form my complete sample in the analysis (Table. 5.1). Which are:-

- sample 1) is the *main sample*, referred to as M and includes $n = 213$ points which came from all seven regions from each of the four main site types, including some isolates described in Chapter 2. M is made up of original and replica casts (Tables. 3.1; 5.1). All of these are included in the geometric morphometric analysis (GM) and principal components analysis (PCA)
- sample 2) is the c*omparative sample*, referred to as C, which includes isolates and surface-collected points, and comprises $n = 77$ specimens. These are original and cast replicas (Tables. 3.2; 5.1). Those isolates and surface-collected points which were included in my M sample do not appear in this sample. None of C appear in the GM / PCA analysis
- sample 3) is a *supplementary* sample referred to as S, made up of original points, replica casts and illustrations / images of points from well-documented published sources, where I did not have access to the assemblages (Tables. 3.3; 5.1). They include material from all the site types in Chapter 2 and some occur in the GM / PCA analysis

The total number of Clovis points from my three samples was $n = 298$; samples 1) $n = 213$, and sample 2) $n = 77$, plus what were used from sample 3) $n = 8$, will make up my complete sample that will form the analysis in Chapter 5 (Table. 5.1). The number of points in the analysis will have been reduced down from original sample totals, after applying the selection criterion set out for the particular programme I chose for my methodology. This will discussed further in my methods section below. However, the points that did not go through my selection process may still be part of that particular assemblage's basal variability assessment overall.

MAP REF	SITE / LOCATION (listed A-Z by site)	REGION & SUBREGION	SITE TYPE	*n* = POINTS: MY SAMPLE	TOTAL *n* = ORIGINAL ASSEMBLAGE*	SLADE IDENTIFER
01	Anzick, Park County, MT	Northern Plains	Cache	05	08	ANZ
02	Badger Mountain, Douglas County, WA	Northwest	Surface	01	01	BAM [#]
03	Bigbee Ranch, Torrance County, NM	Desert Southwest	Kill / Surface	01	01	BGB
04	Blackwater Draw, Roosevelt County, NM	Desert Southwest	Kill / Camp	24	unknown	BWD
05	Borax Lake, Lake County, CA	Southwest & Great Basin	Camp	04	unknown	BXL
06	Bull Brook, Essex County, MA	Northeast	Camp	18	unknown	BBK
07	Bull Creek, Beaver County, OK	Southern Plains	Kill / Surface	01	01	BUL
08	Cactus Hill, Sussex County, VA	Middle-Atlantic	Camp	02	unknown	CTH
09	Camp Pecometh, Queen Anne's County, MD	Middle-Atlantic	Isolate	01	01	CMP
10	Carson-Conn-Short, Benton County, TN	Southeast	Camp / Workshop	02	02	CCS
11	Casper, Natrona County, WY	Northern Plains	Isolate / Surface	01	01	CSP
12	Colby, Washakie County, WY	Northern Plains	Kill	04	04	CBY
13	Debert, Colchester County, Nova Scotia, CAN [1]	Northeast	Kill / Camp	05	unknown	DEB
14	Dent, Weld County, CO	Northern Plains	Kill	02	02	DEN
15	Dietz, Lake County, OR	Northwest	Camp	01	01	DTZ
16	Domebo, Caddo County, OK	Southern Plains	Kill	03	03	DOM
17	Drake, Logan County, CO	Northern Plains	Cache	13	13	DRK
18	East Wenatchee, Douglas County, WA	Northwest	Cache	02	14	ETW
19	Eckles, Jewell County, KS	Southern Plains	Kill? / Camp	02	02	ECK

20	El Fin del Mundo, Sonora, MEX	Desert Southwest	Kill	02	05	EFM
21	Escapule, Cochise County, AZ	Desert Southwest	Kill	02	02	ESC
22	Fenn Cache, UT/WY/ID border	Northern Plains	Cache	07	23	FEN
23	Gault, Bell County, TX	Southern Plains	Camp	02	unknown	GLT
24	Hell Gap (vicinity), Goshen County, WY	Northern Plains	Camp	02	02	HEL
25	Hoyt, Lake County, OR	Northwest	Camp / Surface	02	02	HYT
26	Jake Bluff, Harper County, OK	Southern Plains	Kill / Camp	03	04	JBF
27	Kimmswick, Jefferson County, MO	Midcontinent & Great Lakes	Kill	03	03	KIM
28	Klein, Weld County, CO	Northern Plains	Kill? / Surface	02	02	KLE
29	Lamb, Genesee County, NY	Northeast	Camp	07	10	LMB
30	Lange-Ferguson, Shannon county, SD	Northern Plains	Kill	02	03	LGF
31	Lehner, Cochise County, AZ	Desert Southwest	Kill	08	13	LEH
32	Leikem, Cochise County, AZ	Desert Southwest	Kill / Isolate	01	01	LEK
33	Lewisville, Denton County, TX	Southern Plains	Kill / Camp	01	01	LEW
34	Miami, Roberts County, TX	Southern Plains	Kill	03	03	MIA
35	Mueller-Keck, St. Clair County, IL	Midcontinent & Great Lakes	Camp	04	unknown	MUK
36	Murray Springs, Cochise County, AZ	Desert Southwest	Kill / Camp	06	18	MSP
37	Naco, Cochise County, AZ	Desert Southwest	Kill	08	08	NAC
38	Paleo Crossing, Medina County, OH	Midcontinent & Great Lakes	Camp	01	04	PAL
39	Plenge, Warren County, NJ	Northeast	Camp	09	unknown	PGE
40	Rummells-Maske, Cedar County, IA	Midcontinent & Great Lakes	Camp / Cache	05	23	RMK
41	Shawnee-Minisink, Monroe County, PA	Northeast	Camp	02	02	SMK
42	Sheaman, Niobrara County, WY	Northern Plains	Camp	01	01	SHM
43	Shoop, Dauphin County, PA	Northeast	Kill / Camp	10	unknown	SHP
44	Simon, Camas County, ID	Northwest	Cache	04	05	SIM
45	Sloth Hole, Jefferson County, FL	Southeast	Kill / Camp	02	02	SLH
46	Vail, Oxford County, ME	Northeast	Kill / Camp	22	unknown	VAL
			TOTAL *n* =	**213**	**~ 250**	

** Total number of points in the assemblage if known. Further analysis on remainder of the Clovis point assemblage possibly available through published material*

[#] Specimens that are part of the comparative C sample 2) and are included in this dataset

[1] After my study of these points, one specimen (DEB 02) was discovered to actually come from Cape Blomidon (CPB 01) close to the Debert site, but remains in the sample (see Appendix C)

Table. 3.1 Clovis and Clovis-aged fluted points from the four main site types I identified with map reference numbers (Figure. 3.1), that make up the main M sample 1). An excel spreadsheet and digital photographic record of all these points is available on CD (Appendix. C)

MAP REF	SITE / LOCATION (listed A-Z by site)	REGION	CLOVIS POINT TYPE* & QTY	COMMENTS	SLADE IDENTIFER
01	Adams County, IL	Midcontinent & Great Lakes	Clovis 01	Ex Mr H.J. Collection	ADC
02	Barton Creek Township, Wake County, NC	Southeast	Clovis 01	Specimen #36 in Perkinson (1973) found by Mr D. Ray	BCT
03	Beatrice, Gage County, NE	Northern Plains	Clovis 01	Mr R. Miller Collection	BEA
04	Belgreen, Franklin County, AL	Southeast	St. Louis variant 01	Mr C. Moore Collection	BEL
05	Big Sioux River, Woodbury County, IA	Midcontinent & Great Lakes	Clovis 01	Found by a park ranger in 1998 Knife River Flint (chert)	BSR
06	Bishop Hill, Henry County, IL	Midcontinent & Great Lakes	Clovis 01	Illinois State Museum Collection	BSH
07	Bone Lick, Boone County, KY.[1]	Southeast	Clovis 01	Carter / Haney chert	BLK
08	Boone County, KY	Southeast	Clovis 02	Carter / Paoli chert Lake Cumberland chert	BOC
09	Bostrom, St. Clair County, IL	Midcontinent & Great Lakes	Clovis 02	Kaolin chert Burlington chert	BOS
10	Brooklyn, Craighead County, AR	Southeast	Ross County variant 01	Arkansas Archaeological Survey - Morse and Morse (1983)	BKN
11	Brownstown, Fayette County, IL	Midcontinent & Great Lakes	Clovis 01	NFI Cobden-Dongola chert	BTN
12	Bruneau River, Owyhee County, ID	Northwest	Clovis 01	NFI	BRR
13	Buckheart Township, Fulton County, IL	Midcontinent & Great Lakes	Clovis 01	Mr M. Meadows Collection Hixton silicified sandstone	BKT
14	Cape Fear River, Harnett County, NC	Southeast	Clovis 01	NFI	CFR
15	Carter / Kerr-McGee, Campbell County, WY	Northern Plains	Clovis 01	Mr R.J. Smith Collection - Frison (1978, 1984)	CKM
16	Cedar Creek, Monroe County, IA	Midcontinent & Great Lakes	Clovis 01	Mr K. Deyo Collection Burlington chert	CDK
17	Cerro Guaymas, Sonora, MEX	Desert Southwest	Clovis 01	Di Peso (1955) obsidian	CRG
18	Claypool, Washington County, CO	Northern Plains	Clovis 01	Dick and Mountain (1960) Stanford and Albanese (1975)	CPL
19	Cumberland River, Trigg County, KY	Southeast	Ross County variant 01	Mr B. Sheka Collection Dover chert	CMR
20	Dalhart, Dallam / Hartley Counties, TX	Southern Plains	Clovis 01	Meltzer and Bever (1995)	DAL
21	Dugway Military Proving Ground, Toole County, UT	Southwest & Great Basin	Clovis 01	Mr R. Norwicki Collection obsidian	DPG
22	Dutton, Yuma County, CO	Northern Plains	Clovis 01	Stanford (1979)	DUT
23	Elkhart, Morton County, KS	Southern Plains	Clovis 01	NFI	ELK
24	Fern Ridge Reservoir, Lane County, OR	Northwest	Clovis 01	Connolly (1994) reddish-brown local chert	FRR
25	Fort Rock Valley, Lake County, OR	Northwest	Clovis 01	Prehistoric America Journal Vol. 17 - Malheur chert	FRV
26	Fox, Weld County, CO	Northern Plains	Clovis 01	Mr M. Fox Collection - Holliday (1987)	FOX
27	Fulton, Hickman County, KY	Southeast	St. Louis variant 01	Mr D. Rogers Collection Dover chert	FTN
28	Gainey, Genesee County, MI	Midcontinent & Great Lakes	Clovis 01 (Gainey)	Mr P. Stork Collection ? Upper Mercer chert	GNY
29	Genesee County, MI	Midcontinent & Great Lakes	Clovis 01 (Gainey)	Ex Mr Dodge Collection	GEC
30	Gibson County, IN	Midcontinent & Great Lakes	Ross County variant 01	Mr D. Rogers Collection - yellowish agate, transported a considerable distance	GIC
31	Grangeville, Idaho County, ID	Northwest	Clovis 01	Discovered in house in 1950s semi-translucent chalcedony	GRG
32	Greeley, Weld County, CO	Northern Plains	Clovis 01	Holliday (1987)	GLY

33	Hartville, Platte County, WY	Northern Plains	Clovis	01	NFI Hartville chert	HRT
34	Jay County, IN	Midcontinent & Great Lakes	St. Louis variant	01	NFI unsourced obsidian	JYC
35	Jefferson Island, Talbot County, MD	Middle-Atlantic	Clovis (unfluted)	01	NFI	JEF
36	Jerome, Jerome County, ID	Northwest	Clovis (unfluted)		NFI Olive-grey chert	JER
37	Kersey Gravel Pit, Weld County. CO	Northern Plains	Clovis	01	Holliday (1987)	KGP
38	Laramie Park, Albany County, WY	Northern Plains	Clovis	01	NFI red jasper	LPK
39	Lincoln County, CO	Northern Plains	Clovis	02	NFI	LNC
40	Lower Hooper Island, Dorchester County, MD	Middle-Atlantic	Clovis	01	NFI	LHI
41	McLean County, ND	Northern Plains	Clovis	01	NFI Knife River Flint (chert)	MCC
42	Meekins Neck, Dorchester County, MD	Middle-Atlantic	Clovis	03	Lowery and Phillips (1994) Heavily black / grey patinated orange or yellow Jasper	MNK
43	Buffalo Junction, Mecklenburg County, VA	Middle-Atlantic	Clovis	01	Mr T. Jones Collection - Wormington (1939)	BFJ
44	Molina, Apache County, AZ	Desert Southwest	Clovis	01	Apache-Sitgreaves National Forest Collection - Haynes (2011)	MOL
45	Nellie Heights, Coshocton County, OH (nr the Welling site)	Midcontinent & Great Lakes	Clovis	01	Johnson-Hunrickhouse Museum Collection - Prufer and Wright (1970) Upper Mercer chert	NHS
46	Nelson, Weld County, CO	Northern Plains	Clovis	01	Found amongst Cody complex	NEL
47	Nez Perce, Nez Perce County, ID	Northwest	Clovis	01	Smithsonian Institution Collection - Found in 1869 by US Army surgeon on an Indian reservation	NEZ
48	Niobrara County, WY	Northern Plains	Clovis	01	University of Wyoming Collection	NBC
49	Oxford, Granville County, NC	Southeast	Clovis	01	Mr Capeheart Collection - Specimen #31 in Perkinson (1973) found by Mr R. Dean	OXF
50	Pike County, IL	Midcontinent & Great Lakes	Clovis	01	Private Collection - found 1985 Burlington chert	PKC
51	Randolph County, IL	Midcontinent & Great Lakes	Clovis	01	Illinois Archaeological Survey Kaolin chert	RDC
52	Rathburn Lake, Appanoose County, IA	Midcontinent & Great Lakes	Clovis	01	Mr K. Deyo Collection - Spears (1967)	RBL
53	Red River, Red River County, TX	Southern Plains	Clovis	01	NFI	RDR
54	Riders Mill, Hart County, KY	Southeast	Clovis	01	Mr Logsdon Collection Boyle chert	RDM
55	Roaring Springs, Motley County, TX	Southern Plains	Clovis	01	NFI Tecovas jasper	RSP
56	Rogers Shelter, Benton County, MO	Midcontinent & Great Lakes	post-Clovis (Dalton)	01	Illinois State Museum Collection - Ahler and McMillan (1976)	RGS
57	Seminole Draw, Gaines County, TX	Southern Plains	Clovis	01	Kibler (1991) Edwards chert	SEM
58	Saverton, Ralls County, MO	Midcontinent & Great Lakes	Clovis	01	NFI	SAV
59	Schaldack, Cochise County, AZ	Desert Southwest	Clovis	01	Arizona State Museum - Ayers (1970)	SHK
60	Seagull Bay, Power County, ID	Northwest	Clovis	01	Reid *et al.* (2014) Big Southern Butte obsidian	SGB
61	Silver Creek, Stephenson County, IL	Midcontinent & Great Lakes	Clovis	01	NFI Burlington chert	SCK
62	St. Clair County, IL	Midcontinent & Great Lakes	Ross County Clovis	01 01	Mr F. Ritter Collection Mr P. Bostrom Collection both points Kaolin chert	SCC
63	Sulphur (North) River, Fannin County, TX	Southern Plains	Clovis	01	Mr K. Bush Collection Butterscotch chert	NSR
64	Turkey Farm, Weld County, CO	Northern Plains	Clovis	02	Mr L. Klein Collection - Holliday (1987)	TKF

65	Union County, IL	Midcontinent & Great Lakes	Clovis 01	St. Louis Science Center Collection - Sugar quartz	UNC
66	Wagon Mound, Mora County, NM	Desert Southwest	Clovis 01	NFI	WGM
67	Welling, Coshocton County, OH	Midcontinent & Great Lakes	Clovis 01	Johnson-Hunrickhouse Museum Collection - Prufer and Wright (1970) Vanport Flint (chert)	WEL
68	Wheatland, Platte County, WY	Northern Plains	Clovis 01	NFI	WTD
69	Willie, Phillips County, AR	Southeast	Ross County variant 01	Arkansas Archaeological Survey Collection - Morse and Morse (1983) Crowley's Ridge Gravel chert	WIL
70	Wray, Yuma County, CO	Northern Plains	Clovis 01	NFI	WRY
			TOTAL *n* = 77		

** Clovis point types in this table are taken from published sources and my visual observations before the reclassification, however the term Clovis-like was still dropped from the description*

[1] The Bone Lick Clovis point is not to be confused with the Clovis site of Big Bone Lick, also in Kentucky, it is a separate locality

Table. 3.2 Isolate and surface-collected Clovis and Clovis-aged fluted points that make up sample 2), with map reference numbers (Figure. 3.2). A digital photographic record of all these points is available on CD (Appendix. C)

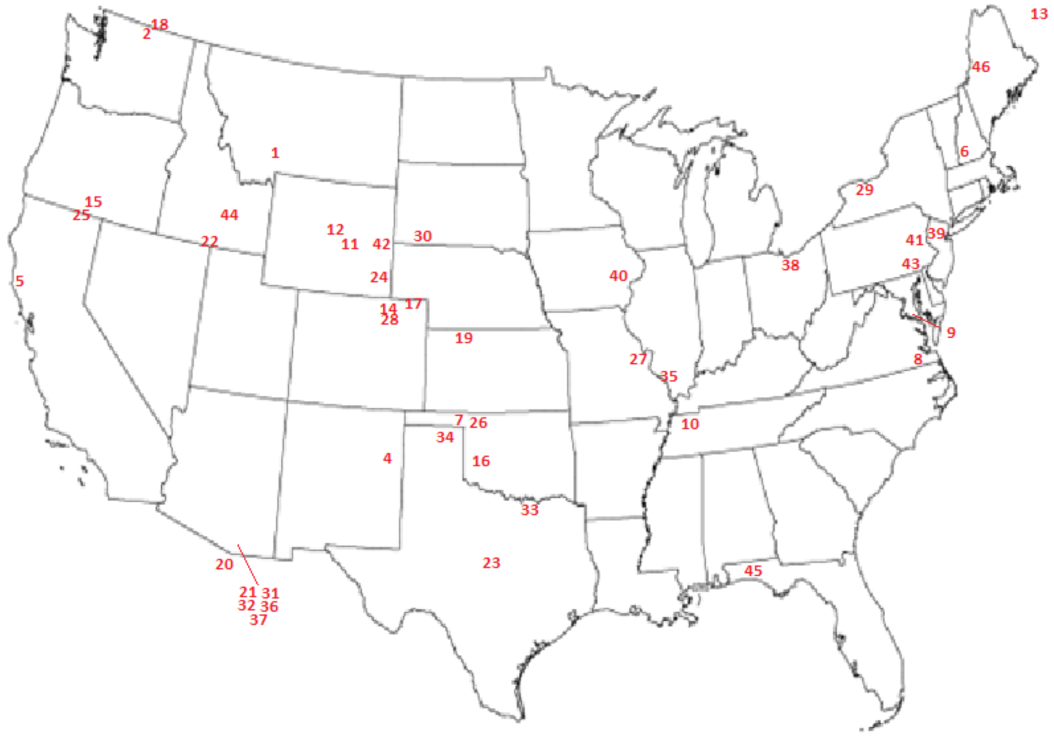


Figure. 3.1 Map showing the locations of the Clovis points that made up sample 1): See Table. 3.1. Site number 13 is in Canada and number 20 in Mexico and fall outside the U.S. map

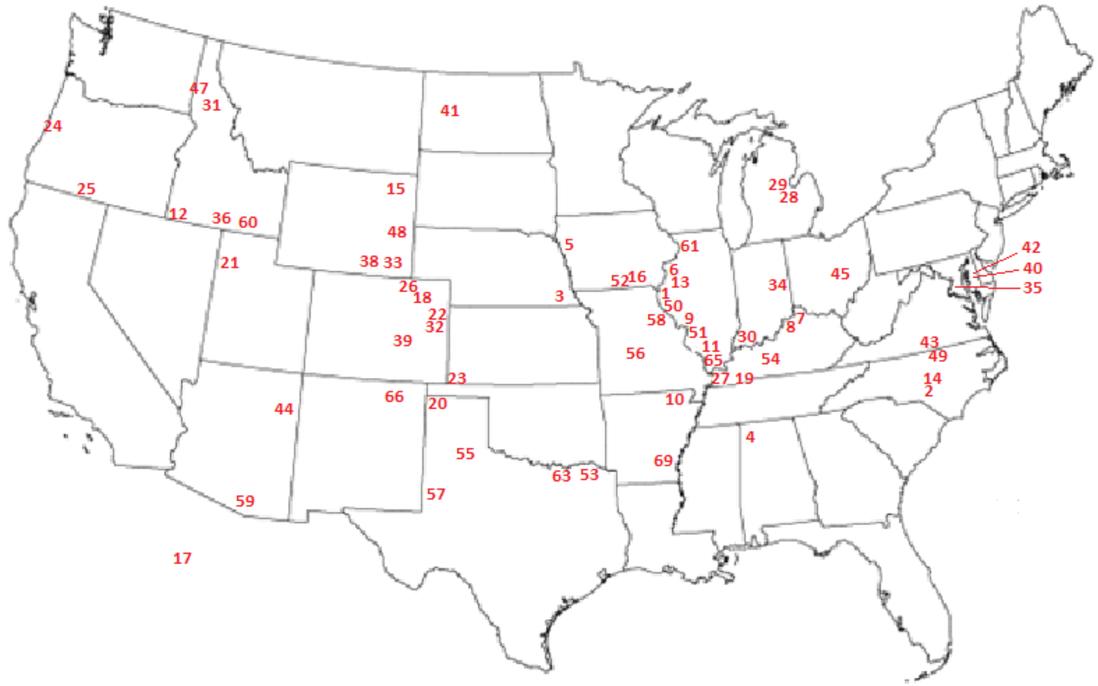


Figure. 3.2 Map showing the locations of findspots for the isolates / surface-collected Clovis points that made up sample 2): See Table. 3.2. Site number 17 is in Mexico and falls outside the U.S. map

MAP #'S	SITE / LOCATION	REGION	SITE TYPE	COMMENTS	PUBLISHED SOURCE
01	Adams, Christian County, KY *	Southeast	Quarry / Camp	Little River Clovis Complex, and part of the Yahnig Collection. C. Yahnig made available images of the points for analysis	Sanders (1988, 1990) Gramly and Yahnig (1991)
02	Big Bone Lick, Boone County, KY	Southeast	Kill / Camp	Clovis points associated with mastodon remains Possibly one of the first ever Clovis fluted points discovered, metrics available from PhD research with permission from K.B. Tankersley	Tankersley (1985, 1989) Tankersley *et al.* (2009)
03	Big Eddy, (23CE426), Cedar County, MO	Midcontinent & Great Lakes	Camp	Clovis points and other lithics, possible pre-Clovis candidate component, Clovis points part of the Clovis / Gainey association. Analysis made from published material	Ray *et al.* (1998)
04	China Lake, Kern, Inyo, and Bernardino Counties, CA	Southwest & Great Basin	Surface-collected	A series of eroded Clovis-aged archaeological sites that yielded Clovis fluted points. M Rondeau made his point database available through research reports	Rondeau (2003, 2005) Davis (2005) Yohe II and Gardner (2016)
05	Lake Cascade, (10VY563), Valley County, ID *	Northwest	Isolate / Surface-collected	Clovis fluted point made from Timber Butte obsidian.	Titmus and Woods (1991) Reid *et al.* (2014)
06	McFaddin Beach, (41JF50), Jefferson County, TX	Southern Plains	Isolate / Surface-collected	Clovis variant points and other lithics washed up on the shoreline from buried undisturbed sites	Turner and Tanner (1994) Patterson (2000)
07	Mockingbird Gap, Socorro County, NM	Desert Southwest	Camp / Surface-collected	Many Clovis basal fragments present in large campsite assemblage. P LeTourneau made his analysis available for study	Huckell *et al.* (2008) Holliday *et al.* (2009) Hamilton *et al.* (2013)
08	Ready / Lincoln Hills, Jersey County, IL	Midcontinent & Great Lakes	Quarry / Camp	Published material available, as I was unable to get access to either original or casts of the Clovis points	Morrow (1995)
09	Sugarloaf Site, Franklin County, MA*	Northeast	Camp	Clovis fluted points, and other lithics. R.M. Gramly made available images and illustrations of the points for analysis	Gramly (1998, 2014)
10	Upper Cross Creek, Washington County, WA	Northeast	Isolate / Surface-collected	Pristine and unsharpened, found in 2010 by a collector, it is made on Belleville chalcedony, from central Pennsylvania, and represents one of only a few Clovis fluted isolates from the region	Gramly (2011)
11	Williamson, Dinwiddie County, VA	Middle-Atlantic	Quarry / Camp	A multicomponent Paleoindian site, including a multi-activity Clovis locality. Point analysis taken from published material	McCary (1951) Hill (1997)

** Access to good quality epoxy resin replicas of these points was possible, so an accurate metric analysis was also carried out on these specimens*

Table. 3.3 Important Clovis point assemblages that I did not have access to and do not appear in my main analysis. I was able to carry out analysis on the assemblage from published sources and non-published material for supplementary analysis that makes up sample 3): see Appendix. C). Numbers refer to findspots on the map: see Figure. 3.3

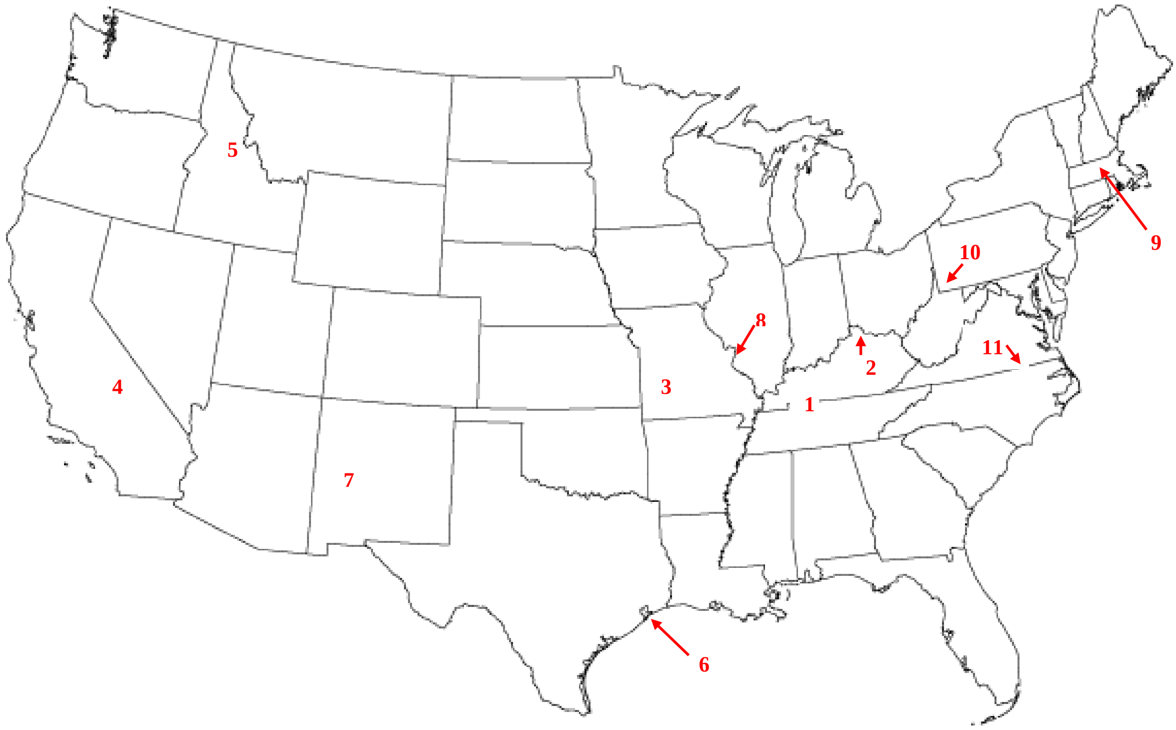


Figure. 3.3 Map showing the locations of findspots for the Clovis fluted point assemblages that make up sample 3) of the supplementary material: see Table. 3.3

I left out most of the isolate / surface-collected points from sample 1) as there is usually only one point represented, they are not often published or well-documented, and I felt that these points could adversely influence the results of my analysis on site assemblages that had numerous points. The isolated point specimens I left in are either associated with other site assemblages nearby, or have been published and are in the archaeological record. Previous studies of Clovis point variability have neglected these points in their analysis (*e.g.* Buchanan *et al.* 2014), arguing that including them would bias their results, and along with other recent comparable studies (see Buchanan and Collard 2007; Buchanan and Hamilton 2009; Sholts *et al.* 2012) chose to use only Clovis points from a sound archaeological context (Buchanan *et al.* 2014:147). However, I chose to include the isolates and surface-collected Clovis fluted points I had access to for the sample 2) material (Table. 3.2), as I felt that they were an important and valuable addition to the understanding of Clovis movement in any particular region across North America, and were also a good marker for lithic toolstone occurrences. Thousands of isolated, surface-collected Clovis points have been found across North America (Anderson and Faught 2000), and including the specimens I had access to will significantly increase my understanding of the variability of Clovis fluted points, and raw material selection. I could also compare the isolated points characteristics and flaking styles with points from well stratified and datable contexts, where perhaps only a few examples are present.

3.2.1 Selection criteria: sample 1), M

The assemblages of Clovis points that made up sample M, had to meet certain criteria that justified their inclusion. Firstly the assemblage had to be accurately dated, or have credible dates with a definite Clovis association (Table. 2.2). For the purpose of this study I used the Clovis date range set out in previous chapters, which has Clovis beginning ~ 11,050 ^{14}C yr BP, and finishing ~ 10,800 ^{14}C yr BP (Waters and Stafford 2007, 2013). Secondly the points, or good quality resin cast replicas, were available for study and underwent a metric analysis and have a digital photographic record. My rationale and justification for using good quality resin replicas of Clovis points is explained in more detail in the data collection section below. Lastly, the point assemblages that made up this sample came from reliably-excavated, and /or from well-documented published sources which were identified during my extensive literature review in Chapter 2.

3.2.2 Selection criteria: sample 2), C

For sample C, my comparative dataset, I used the isolate and surface-collected specimens. The criteria for the inclusion of these points were the same as sample 1), although the lack of dating for these points is a key difference. A major justification for the inclusion of these points was that they increase the regional distribution of Clovis point occurrences as well as being a good raw material type record (Figure. 3.3).

3.2.3 Selection criteria: sample 3), S

There were a few important and well-documented Clovis point assemblages and isolates that I did not get access to for a full analysis (Table. 3.3). However I did manage to get good quality illustrations of the points, which can be used in my analysis and provide a good comparative test. In a few cases I also got access to some good quality replicas of the points (Slade 2018), which meant that these points could go through the caliper-based metric analysis and PCA process (Table. 5.1).

An important factor concerning the selection of individual points from the assemblages for all my samples, was that all points selected had to display a relatively undamaged base. All points that had basal ears missing, and any other severe basal damage, were removed from the analysis. However, the technological characteristics, and raw material type was noted, as they played a very useful part in the point assemblages overall assessment.

3.3 Methods: quantative variables and geometric morphometrics

For my study of basal concavity variability of Clovis points I chose to carry out a three-way analysis on the samples:-

- firstly a caliper-based measurement analysis was carried out on all points from every assemblage (Appendix. C) that made up my complete sample; samples M and C (Table. 5.1)
- secondly, I carried out a geometric morphometric shape analysis involving principal component analysis (PCA) on points from assemblages from sample 1), analysing the shapes and style of the concavities of the points' bases
- thirdly, the assemblages that went through the PCA analysis were entered into a programme that statistically tested the resulting patterns using a multivariate analysis of variance (MANOVA). The metric analysis of the basal concavity width and depth will also be presented for each assemblage (Table. 5.2)

The caliper-based shape analysis of the point's basic characteristics was carried out with a set of digital calipers (Figure. 3.4). I measured each point's maximum length (ML) maximum width (MW), maximum thickness (MTh), basal concavity width (CW), basal concavity depth (CD), maximum flute width (FW), and maximum length of flute (FL). The latter two records were taken on both faces of the point. I drew up a record sheet that included these measurements and other comments on a particular point's metric characteristics. The majority of these measurements had been taken previously (Slade 2010), and some of the data from that were retained for this study. Where I did not have those data, a new metric analysis of those points was carried out.

The record sheet also included a description of the specimen's non-metric characteristics, including its condition, completeness and any damage that the point displayed, and when the point was found, if known. The specimens were recorded by site or locale and their Smithsonian trinomial site code if known, these are unique identifiers assigned to some North

American archaeological sites (Appendix. D). The specimens are then recorded by state, county, nearby town or city if applicable, and then the region which they were in. I also made a note when and where I carried out the analysis, and in which institution or private collection they are in. Details of the current location of the original specimens were also listed. If the point was a cast replica, then the location of the cast collection was given. These data are presented in more detail in my analysis chapter (Table. 5.1). A digital photographic record was carried out at the same time as the record sheet was completed. A good quality image of the obverse and reverse of the point with a metric scale was produced for every point (Appendix. C).

For the PCA I selected one face of the point; the face I chose was the face that displayed what I considered the most worked face, in so far as, the face that displays the most distinct fluting and flake scars. When I was carrying out my data collection, I implemented this methodology for my metric analysis and photographic record; the two faces being referred to as the obverse (dorsal) and reverse (ventral) faces. I carried on with this consistency throughout my methodology in this study.

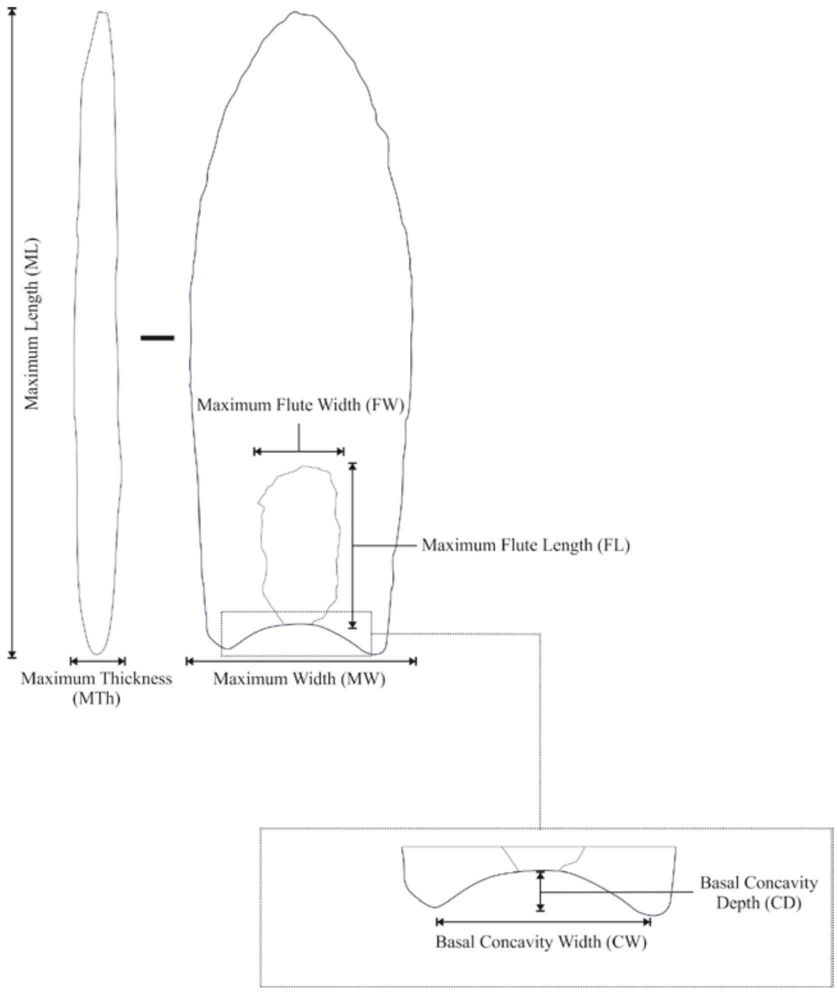


Figure. 3.4 Clovis fluted point metric recording strategy, indicating the points characteristics that highlight the basal morphology (Illustration by C. Hoggard 2016)

My basal analysis on the points will be carried out on three variables: basal concavity width, basal concavity depth, and overall basal shape and style, including the basal ear morphology. The basal concavity width measurement (see Figure. 3.4) was taken from inside the basal ears to give a more accurate concavity measurement, whereas other studies on basal concavity used the complete basal section width measurement (*e.g.* Tankersley 1989a; Morrow 1996). Most studies, when measuring basal concavity depth (Gramly 1982:27; Ellis 2004:226), measure the distance from a line linking the apexes of the basal ears. If one ear is longer than the other, the view is that the longest ear is a better approximation of the true depth of the concavity, as the shorter ear is the product of a breakage.

These variables will help to answer whether: a) there is a regional variability of Clovis fluted points based on basal concavity morphology; b) is there a variability of Clovis fluted points within certain Clovis site types; and c) are certain toolstone types influencing variability. This analysis will address my overall research question objectives laid out in Chapter 1. Basal concavity depth and width of the fluted point will indicate how much individual variation within a particular assemblage is present.

For my geometric morphometric PCA test I had to select only the unbroken points from each assemblage, eliminating those that did not reach my selection criteria laid out above. Only assemblages that had three or more points could be used, so that a realistic result that reflected the variation was produced. The first two principal components: PCA 1 and PCA 2, were used to display the variation. The PCA will be carried out on Clovis points in M from good quality photographic images which were taken during my data collection research from 2008 to 2010, and from 2012 to 2015 in North America (Appendices. B, C), and from published material on a few assemblages in sample 3).

The PCA takes the variability present in a series of pre-existing artefact attributes (variables) and recombines it into a series of new variables which link aspects of the former variability together. The two most important new variables are designated PCA 1 and PCA 2. More are available if one so wishes, but for the purpose of my study, I was concerned with the first two principal components. PCA allows for the visualisation of shape changes, Each new variable (axis / principal component on a PCA visual plot) will have a weight, i.e. how much variation can be accounted for by one principal component *e.g.* PCA 1 [56.4%] and

PCA 2 [24%]. If the two do not add up to around 75% I'll consider using the third principal component.

The process I adopted was to use the CorelDraw X7 program and import images (as good quality jpeg's) from my dataset and scaled the image to fit (10% scaling). A 'graph paper' template with ten columns was then added, one row allowing eleven landmarks to be plotted on the grid. Ensuring that the grid was as wide as the basal concavity (*e.g.* from the apex of the concavity to the extremities) and that the top two corners of the grid followed the outline of the point (Figure. 3.4). I then selected the graph paper to the hairline setting, allowing for more accurate placing of the landmarks on the grid. Once the grid was applied to the basal image, the image was exported as a high quality jpeg to a suitable folder, and repeated for the whole point assemblage of the selected site. I then used the tpsUtil32 and tpsDig computer programs (Rohlf 2008, 2010) to perform the geometric morphometric analysis and which allowed me to build TPS files from my images of the points. The tps files were then exported into the PAST3 program which generated PCA results, an example of which can be seen below (Figure. 3.5).

The third element of my analysis was a MANOVA test on the PCA data. The MANOVA (Wilk's Lambda; Pillai Trace) assesses whether or not statistically significant differences exist between the patterns of basal point shape in the PCA for each assemblage. This helps in identifying whether there are groups which can be discriminated within a region. A pairwise MANOVA highlights that this is specifically between certain groups of a certain region, in other words, basal concavities differ in two-dimensional shape. In PAST, the statistical programme, there are three outcomes: Fail) where the sample size is too small; Bold) where that outcome is statistically different; and Normal) where it is statistically similar, i.e. $p = > 0.05$. The MANOVA results will be presented alongside the relevant graphs where possible.

In my previous study of Clovis fluted point variability (Slade 2010), it was the differences in the basal sections of Clovis points that first led me to believe there may be regional variability in Clovis point basal morphology, and that a detailed analysis of basal morphology on the points might help understand Clovis fluted point variability on a continental scale (Slade 2014). This analysis will address the morphological variation in the basal concavity of Clovis points, and help clarify whether different regions of North America have a variation in basal concavity in Clovis point technology.

3.4 Clovis point and site selection

In terms of regional distribution, only the Southwest and Great Basin region is under-represented, with five points in the analysis from two assemblages. This region does have point assemblages that are considered to be Clovis (see Bryan 1991; Beck and Jones 1997, 2010), but at the time of my data collection, there were no other assemblages of suitable points available for study other than the ones I had access to. The Southeast subregion also lacked Clovis-aged sites that had points that were available to study, but I did manage to get access to twelve isolate, surface-collected points from eleven different locations, as well as comparing the results with some published material from other Clovis sites in the region (Tables. 3.2; 3.3; 5.1). Previous studies of Clovis on a continent-wide scale have also had limited results, or in some cases none at all, from these regions (*e.g.* Buchanan 2005; Buchanan and Collard 2007; Buchanan *et al.* 2014), and neglected to include them in their overall study. For a more complete and comprehensive view of variability of the whole of North America I included these regions.

The detailed investigation of all the Clovis sites I have already reviewed in Chapter 2 (Table. 2.1), and the analysis of the Clovis points from these sites that made up my complete sample, M, C, and S (see Table. 5.1), represent, in my opinion, the majority of the best-dated (Table. 2.2), and best contextualised Clovis point assemblages in North America (Table. 2.1).

Aside from the criteria mentioned above for the analysis of the Clovis points, I had to select and discount certain points from assemblages that could not go through the analysis process. As I had chosen basal morphology, the specimens that had their basal section missing, or heavily damaged, would therefore have to be removed from my analysis of that particular assemblage. However, on interpreting the results of my analysis on a Clovis assemblage overall, it would be possible to visually interpret whether certain points that had minimal damage to the basal section, but were omitted, were significantly different or similar to that particular assemblage. My analysis of the point's basal section, also meant that certain points that had severe damage to the blade and midsections, or points that only had the basal section remaining, could be included in my broader analysis.

A good example of this is the Rummells-Maske assemblage from Iowa (Anderson and Tiffany 1972; Morrow and Morrow 2002b). Several of the Clovis points in this assemblage had the blade section missing, but had little or no damage to the basal section. Other specimens in the assemblage displayed only slight damage to the basal 'ears' but could not be included in the analysis. The damage to the basal section and the missing ears on some of these points, did not suggest that these points would have shown any morphological variation to the rest of the assemblage.

3.5 Data collection: artefact assemblages, replica casts and collections

In the previous chapter I reviewed the sites and assemblages that would make up my three samples (Tables. 3.1-3.3) and eventually form my complete sample (Table. 5.1). Collections of original Clovis points and good quality cast replicas were studied over a period of years, beginning with my original research in Paleoindian lithic technology in 2008, and continued through to 2015 (Slade 2010, 2012, 2013, 2014). I had access to a number of original Clovis fluted points from the Blackwater Draw site at the research facility in Portales, New Mexico (2008); the Jake Bluff Clovis points in the Oklahoma Archaeological Survey laboratory in Norman, Oklahoma (2009); the Dent site Clovis points; original Clovis points from Colorado, Kansas and Nebraska in the collections at the Denver Museum of Natural History and Science in Denver, Colorado (2009 and 2010); a large number of original Clovis points from the San Pedro Valley sites in the Arizona State Museum in Tucson, Arizona (2011 and 2014); the Gault site points that were available for a brief study at the Gault School of Archaeological Research in Gault in San Marcus, Texas (2014). I also had access to the original Clovis assemblages from a large number of Clovis sites at the Smithsonian Institution, National Museum of Natural History, Department of Anthropology in Washington, DC (2010 to 2014). In addition to these institutions I had access to the private collections of original Clovis fluted points belonging to T. Baker, in Denver, Colorado (2008 to 2012), and C. Yahnig's Little River Clovis Complex collection in Christian County, Kentucky (2012 and 2014). A complete breakdown of when and where these collections were studied appears in the appendices (Appendix. B).

Whilst carrying out my research in the Smithsonian Institution, I became aware of the J. Allen Eichenberger collection of high quality epoxy resin cast replicas. He reproduced casts of the finest quality of most of the well-known Clovis points during the early 1960s up until the early 1980s. The original Clovis casts he made are now part of the Eichenberger Cast Collection in the University Museum of Missouri, Columbia, Missouri, and I have been very fortunate and privileged to have been given permanent access to the image and record sheet database by the collections manager at the museum. At the time Ms. H. Marie Wormington of the Denver Museum commissioned Eichenberger to cast even more Paleoindian artefacts and copies of these also went to C. Vance Haynes that made up the

Haynes Cast Collection, now in the Department of Anthropology, University of Arizona, Tucson. In 1983 the Smithsonian Institution honoured Eichenberger's work and received over six hundred casts of various artefacts in return. With Wormington's casts also going to the Smithsonian on her death, the collection of Clovis casts in the Smithsonian Institution and Arizona museum are substantial.

The mastery of Eichenberger is now being built upon by Mr. P. Bostrom of the Lithic Casting Lab, Mr. J. Chase of Duplicast, and Ms. J. Stanford of the Smithsonian who have produced superb quality casts of Clovis fluted points from site assemblages, isolated surface finds, and points that are in private collections since Eichenberger stopped casting. More recently Mr. M. Frank of the Smithsonian Institution is continuing this important vocation and along with the Eichenberger material provided this study with an invaluable resource. On his death I received a collection of Clovis replica casts from the Baker Collection and these, along with specimens I have been given and bought from the sources above, I have managed to build an impressive collection of some of the most significant Clovis point specimens (Slade 2018). The majority of these casts make up sample 1) and 2), and where originals, cast replicas, or both were used in my analysis, is made clear in my complete sample dataset (Table. 5.1).

Previous studies (Tankersley 1989a; Tompkins 1993; Buchanan 2005; Rondeau 2009a; Buchanan *et al.* 2014) have shown that morphometric comparison of a sample of casts with the original points revealed no significant differences between the originals and casts of the points. Other researchers who carried out analysis on cast replicas have also made similar studies and reported no significant differences (B. Buchanan and M. Eren pers. comm. Austin SAA 2014; M. Rondeau pers. comm. email 2016).

Some limitations are imposed on the study of casts as opposed to original specimens. First, the weight of the point cannot be determined. Further, some casts do not provide accurate attributes on the lateral edges that may indicate grinding, its absence and, or other additional modifications that are apparent on the original specimens. These did not prove too much of a problem in my analysis, as weight was not a key factor in my study. And in regards to the other factors mentioned, the casts that I included in my study were of high quality and every effort was made in the production of these to include these characteristics in the final cast. Also, an attempt at reproducing the colour and texture of the toolstone used features on many, if not all the casts. In some cases study of casts was the only option available as the original specimens were either lost or stolen as in the cases of the Miami and Dent specimens. In some cases the points were not available due the museum collections not being available for study, or the original points were in private collections.

My approach in structuring an analysis on the casts was exactly the same as I would for original specimens, except for those elements already mentioned. The various flake scar patterns, flutes and basal characteristics are all reproduced accurately, and in the case of casts of obsidian specimens, the hafting scratches and abrasions have also been accurately reproduced in the casting process (Rondeau 2009a; Slade 2015, in press a).

3.6 Testing the methodology

To see if my methodology worked, I chose to carry out a preliminary PCA test on a well-documented and researched Clovis site that had a large and varied assemblage of Clovis fluted points made on a variety of different toolstone types.

For the test case I chose the type site for Clovis, Blackwater Draw Locality No. 1, New Mexico. This site represented a large campsite, that was a multi-activity water hole during Clovis times, and was also a multicomponent Paleoindian campsite. My sample was initially twenty-three Clovis fluted points from the assemblage; it is not known exactly how many Clovis points were recovered from the site, as many were recovered by amateur collectors and nearby farmers, and several collections from the early excavations ended up in the respective institutions that sponsored them. But the points in my analysis from the assemblage provided a suitable cross-section of Clovis fluted point technology and displayed a range of basal variability to provide a good test for my methodology. There were several specimens of the traditionally recognised Clovis form, including the two type specimens, and several of the miniature Clovis fluted forms present. Of the original nineteen I chose for the test case, I ended up with sixteen after removing three for not meeting the selection criteria mentioned above. Two of the points had their basal sections missing altogether, and another had undergone severe reworking or maintenance and only half the basal section was present. It had been suggested whilst I was carrying out my data collection analysis, that this point EL 229 (BWD 17) had been modified and was utilised as a hafted knife (D. Stanford pers. comm. Smithsonian Institution Washington DC 2010-2015).

The PCA results that tested the basal variability (Figure. 3.5) from the Blackwater Draw (BWD) point sample were encouraging. When I was originally researching Clovis fluted points, it was the BWD assemblage that first suggested the variability in basal shapes to me (Slade 2010). This test supported that observation. The graph below (Figure. 3.6) highlights the PCA of the first two principal components accounting for 71% (= the sum of PCA 1 plus PCA 2) of all shape variation within my sample *n* = 16. In other words, 71% of all variation of the Clovis fluted points from BWD is accounted for in the first two principle components, and as my sample represents all the variation present in the overall assemblage of points from the site, this test is a good representation of the viability of my method. The range of basal variation within the BWD Clovis point assemblage can be seen below. The outlines of the basal sections illustrated are taken from the 'warp' data (in this case the shapes of the basal sections) that was part of the process of generating the PCA, and are not to scale, but they are a good indication of the variation present in the assemblage. The data are then entered into the PCA programme and a graph plotting the first two principal components can be generated (Figure. 3.6).

For the PCA I selected one face of the point; the face I chose was the face that displayed what I considered the most worked surface. When I was carrying out my data collection, I implemented this methodology for my metric analysis and photographic record. The most worked faces would be the dorsal face, and the opposite face, the ventral face. I carried on with this consistency throughout my methodology in this study.

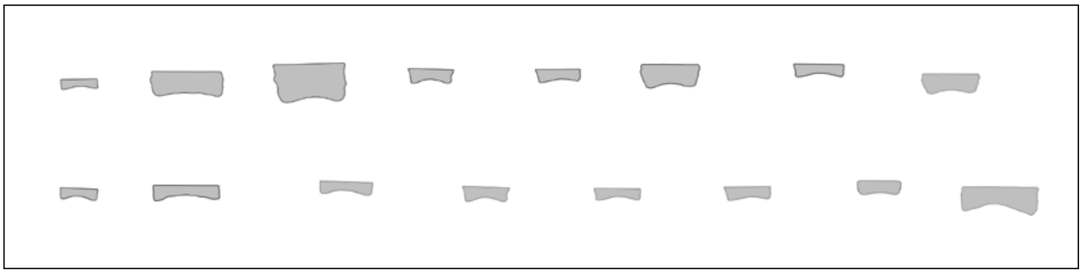


Figure. 3.5 Examples of basal concavity shape variation, generated by geometric morphometric analysis, on the sixteen Blackwater Draw Clovis points that made up the test case sample: (not to scale)

After an assessment of the basal sections of the Clovis points in the BWD assemblage, and the removal of the points that failed the criteria for analysis, the PCA was very encouraging in supporting and representing basal concavity variability in Clovis points. This process will now be implemented on my complete sample in Chapter 5.

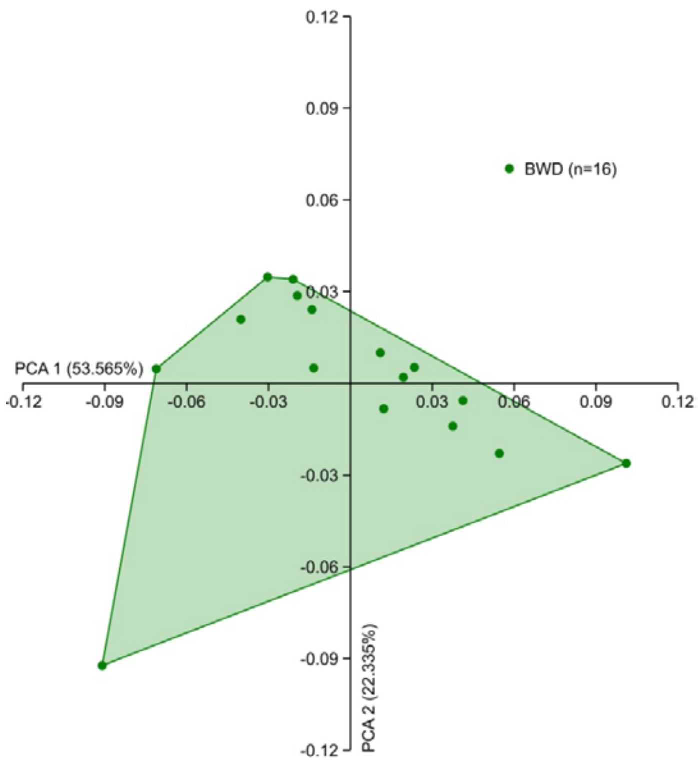


Figure. 3.6 PCA of basal concavity variation on the Blackwater Draw Clovis point assemblage. A combined result of PCA 1 and PCA 2 accounted for 76% of the variation

3.7 Discussion: early conclusions and implications

Overall, the analysis carried out on basal concavity variability using the PCA in the preliminary test was very successful. My methodology stood up to the test, and the results backed up what I had already observed and anticipated in my visual observations of the Blackwater points during my data collection. Namely, there was a range of variability in the basal segments of the Clovis points.

One of the concerns that was brought to my attention, through reading other studies of Clovis point variability, was the issue of reworking of the points that may have been a key factor in point shape (*e.g.* Buchanan 2006; Buchanan *et al.* 2015). Previous studies have suggested that resharpening Clovis fluted points would significantly affect assemblage comparability analyses by altering the size, shape, and flake-scar evidence (*e.g.* Thulman 2012; Shott 2013). One aspect in accepting the re-sharpening issue is that the point base, or basal section, of Clovis points may be the only unmodified and culturally-significant portion of the point (*e.g.* Thulman 2012; White 2013). Minimal maintenance to the point, such as repointing and re-sharpening of the point, would therefore not significantly affect my analysis as most of the shape variation in Clovis points occur around the basal sections.

In a recent paper by Thomas and colleagues (2017), the authors agreed with the suggestion that one consequence of the fluting of Clovis points was that the proximal end, and in particular the basal section was thinned (see Meltzer 2009; Bradley *et al.* 2010). In their paper, Thomas *et al.* (2017) do not mention that their overall approach to Clovis fluting revealed any significant changes to point form or shape as a consequence to the basal thinning that facilitated fluting, although they do suggest that more research should be carried out on the Clovis variants from Debert, Vail, and Lamb from the northeastern North America that display deeper basal concavities.

An encouraging finding from the test case analysis was that the results supported my initial thoughts that possibly more than one Clovis groups fluted points were present in the BWD assemblage. The points from this assemblage visually display a range of point styles and variation in basal concavity shape, and includes a wide variety of lithic material on which the points are produced. In Chapter 5 I will compare the assemblage from Blackwater Draw with other Clovis campsite assemblages in other regions, to see if this pattern is replicated and if variability within campsite assemblages is present, as well as at other Clovis site types. Plus where the toolstone came from, and how far it had travelled from source to findspot.

Chapter 4

Clovis lithic raw materials: regional variability, sourcing and procurement

4.1 Introduction

One of my research aims is to explore the relationship between Clovis point basal shape and raw materials. Tankersley (1994a) has suggested that variation in fluted points results from variability in lithic raw materials and knapping techniques (see Eren *et al.* 2014b). It has also been suggested that Clovis fluted points were well-known from the selectivity of high quality, exotic, and aesthetically coloured toolstone, and the Clovis knappers' excellence in percussion flaking (*e.g.* Haynes 1982; Frison 1991a). An understanding of the relationship between the raw materials used in the production of and the variability within, Clovis points is required before we can fully appreciate any regional morphological differences in the points.

In this chapter I will give a brief overview of the different types of toolstone used by the Paleoindians producing the Clovis fluted points that make up sample 1) M, including <u>some</u> of the more relevant assemblages from sites in C and S samples (Table. 4.2). I will also look at the regional availability and procurement of the toolstone concerning the point assemblages from these sites, as well the distance and direction that some of the material has been transported: either as finished points from source to location, as blanks to be fashioned into finished points, broken and discarded points, or in some cases as a raw material resource (Tables. 4.1, 4.2). Finally, after an interpretation of the data documented in the regional overview, a brief analysis of the movement patterns, and site behaviour on a regional and intraregional scale will be presented.

As I have shown in previous chapters, Clovis in North America is far from homogeneous. Adaptations along the Pacific Coast in the Northwest and Southwest regions, and in the forests of the Southeast are likely to have been quite different from those in the Northern and Southern Plains Regions, or from the tundra conditions in the Midcontinent and Great Lakes, the Northeast and down the Middle-Atlantic coastline. The resources these hunter-gatherers used, the animals they hunted, their annual ranges, patterns of aggregation and dispersals, to their reliance on non-local toolstone, all would have varied from region to region (*e.g.* Speth *et al.* 2013).

It is not known exactly how far the Clovis groups got in their annual movements in search of lithic raw material. In most of the regions there are Clovis-era sites where the toolstone sources can be classed as long distance, or further. Not all toolstone sources have been reliably identified, and there have been attempts to measure the distance between sites and sources that have had distances that may have been either to low or too high (*e.g.* Hester and Grady 1977; Custer *et al.* 1983; Curran and Grimes 1989; Stork and Tomenchuk 1990). In this study, the distance is sometimes based on the straight-line distance between sources of the toolstone found in the point assemblages at the Clovis sites or findspots (but see Lothrop *et al.* 2018). Where this is the case it is recorded in my analysis (Table. 4.1).

In many cases the minimum estimate on the distance between source and site was presented, as Clovis groups would not have travelled in straight lines (Meltzer 2009). So the actual distance travelled by the Clovis groups would likely be as much as twice that distance, and could take, perhaps, two to three times as long (Boulanger *et al.* 2015). These toolstone sources or outcrops are not uncommonly located hundreds of kilometres from where points were later found (see Meltzer 2002; Loebel 2005; Randall and Hollenbach 2007; Boulanger *et al.* 2015). In previous studies, lithic analysts differentiated between 'local' and 'non-local' (exotics) lithic raw materials. Those found over 40 km from the site or location of the assemblage were classed as non-local, or 'exotics' (see Gould and Saggers 1985:119; Meltzer 1989a:31). I compiled my own model of distance parameters based on the distance from the source of the toolstone type to the location where the point appears at any given Clovis site or point findspot (Table. 4.1). The information was taken from the published sources where possible, and the parameters shown were compiled from my own observations and calculations given the data that were available. On occasion where the data were not available but I knew the toolstone type, a literature review of the outcrops of the toolstone was made and a minimum (min) and maximum (max) distance based on a direct or straight-line route was calculated.

The distance parameters that I compiled ranged from locations that the toolstone was sourced from, and where the points were present; these being annual campsites and base camps, kill sites, caches, and finished points represented by isolate and surface-collected finds. The points were made on varieties of lithic raw material ranging from at source (0-5 km) to extreme long distance (2000 km and over). My parameters were:-

- at source; material sourced on site - quarries
- very local; raw material that are within a day's movement, most sites lying well within a 50 km trek
- local; overnight forays required
- regionally local; raw material sourced similar to above, but from within the region or intraregional if on my arbitrary borders
- semi-long distance; toolstone brought in as preforms and in some cases raw material brought in by the group, possibly on annual migrations
- long distance; good to high-quality toolstone present, especially in lithic poor areas. Also can be in areas where respective group had not been before and were unaware of sources - cached sites
- extreme long distance

These distance margins (Table. 4.1) were calculated using the geographical areas I set out in my regional analysis in Chapter 2, and from my observations of the movement of the Clovis groups in the particular region of study based on my literature review of the assemblage in Chapter 2. On presenting my raw material distance model for comment to other Paleoindian researchers experienced in lithic procurement and sourcing lithic material I received favourable responses (D. Amick pers. comm. email 2016; J. Speth pers. comm. email 2016; C. Gamble pers. comm. Southampton 2016) and was offered invaluable advice from others (M. Eren pers. comm. Coventry 2015; K. Healey pers. comm. Southampton 2015; N. Ashton pers. comm. London 2016) who all generously shared some of their research on lithic raw material sourcing. In light of their comments, I am confident that my distance model stands up for testing and I will record the distances using this methodology for the toolstone on the points in my sample analysis. Regardless of the precise definition of local vs. non-local toolstone, there are generally two processes that broadly outline the procurement and sourcing of the lithic raw materials (*e.g.* Funk 2004; Boulanger *et al.* 2015): 'direct' acquisition, where Clovis groups acquired the toolstone themselves in accordance with a degree of group mobility (see Ellis 2011), and 'indirect' acquisition, that has had some form of transfer from one group to another through trade and exchange (see Hayden 1982; Speth *et al.* 2013). In regards to direct acquisition, there is also the debate as to whether lithic raw material procurement was 'embedded' within certain Clovis groups' annual mobility routes, or whether specialist groups made long distance treks to the toolstone sources (see Seeman 1994; Speth *et al.* 2013; Boulanger *et al.* 2015).

In setting out the distance parameters for sourcing and procurement of the raw material used for producing Clovis points, some considerations and comparisons were made from Old World examples (Speth 2016), but for the most part I relied on the distances from published Paleoindian accounts.

DISTANCE PARAMETERS OF RAW MATERIALS FROM ASSEMBLAGE						
0-5 km	**<50 km**	**50 to 100 km**	**100 to 250 km**	**250 to 500 km**	**500 to 1000 km**	**>1000 km**
At Source: Toolstone source, i.e. quarry or workshop	**Very Local:** Material sourced and moved within a day to base camp or workshop	**Local:** Locally-sourced material, overnight stays required, small base camps and manufacturing areas, kill / camps	**Regionally Local:** Material sourced locally within groups region, regular visits or migration routes, major campsites and kill sites	**Semi-long-distance:** Material sourced from within the groups region or regional borders; seasonal campsites and kill sites	**Long-distance:** Good quality raw material transported in or cached locally for later use, in some extreme cases toolstone transported to campsite	**Extreme long-distance:** Exotic or high quality material not usually sourced by group, finished points, maybe for trade or highly prized items, sometimes cached
CIRCUMSTANCES OF CLOVIS POINT PRESENT						
Late-stage preform, early-stage points	Preforms, blanks, and finished points broken in last stage of manufacture	Late stage points, broken and, or discarded points	Finished points left in animal carcass, broken un-recycled points	Finished points left in animal carcass, discarded and some isolated surface points	Late-stage and finished points found in caches, isolated surface finds	Finished points on high quality exotic material, cached and isolated surface finds
PROCUREMENT ACTIVITY						
Preparation of toolstone on-site for transport to nearby workshop	Procurement of nodules, river cobbles and large cores	Prepared toolstone into cores, large blanks and biface preforms, some raw material transported	Mainly semi-finished preparation; preforms, biface blanks, blades, early-stage points	Preparation of toolstone and activities similar to those at source	High quality prepared toolstone (i.e. blanks, blades, and preforms); such as jaspers, alibates, and obsidians etc	Finished points, long distance transport, mainly obsidians or quartz crystal

Table. 4.1 Distances of lithic raw material from site / location of Clovis points in my sample to the source. Based on my own distance parameters

Identification of toolstone types, their sources, and the assemblage location that made up my sample of Clovis points (Table. 4.2), were made from observations taken from published literature of the particular site / findspot of the points, publications providing an overview of raw material used in the production of Clovis-era points on a continental scale (*e.g.* Buchanan *et al.* 2016), and sometimes from personal communications with researchers familiar with the finding and or curation of the particular points. Accurate identification of the lithic raw material, sources, procurement strategies and whether the toolstone was the subject of direct procurement or indirectly acquired can be problematic (see Meltzer 1984, 1989a; Tankersley 1991). Whilst every effort has been made in this study to achieve a high level of accuracy within the criteria above there will undoubtedly be errors as I had to rely on the published literature available from each particular assemblage (Table. 4.2). These data were based on the sample of Clovis points used in my analysis, and therefore does not represent the entire lithic assemblage from that particular site. Details of the relationship between toolstone used at the site and that used to make points in my sample will be clearly noted in the site breakdown below, and in the following chapter.

4.2 Regional analysis of the raw material

The identification of the raw materials used by early Paleoindian groups has always been of interest to researchers and archaeologists, as associating artefacts to specific sources has been a key factor when discussing exchange networks and movement of Clovis-era groups. Fortunately for Paleoindian archaeologists, most of the Clovis points are made from good quality siliceous raw material and are therefore unaffected by corrosive environmental conditions (see Morse *et al.* 1996). As a result the assemblages are made up of: raw materials, preforms / blanks, finished points and other stone tools that can be used to separate major larger sites into three typological groups: base camps, stone procurement areas and tool manufacturing sites, and food procurement and processing sites (Tankersley 1998). This typology can be implemented into breaking down my own distinction of a campsite. The Stone procurement and manufacturing sites were producing and maintaining Clovis points, base camps have evidence of domestic activity and periods of habitation, and food procurement and processing sites display activities such as scavenging, butchery, and food caching. This is demonstrated nowhere better across North America than in the northeast.

In the following section I will review the raw material data from the sites included in the seven regions I identified, and document the outstanding patterns revealed and relevant environmental background that may have influenced these observations.

NORTHEAST REGION
(incorporating the areas of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, and Nova Scotia)

RAW MATERIAL TYPE AND SOURCE WITHIN THE REGION*	SITE NAME AND LOCATION		DISTANCE FROM SOURCE (KM) [1, 2]			DIRECTION OF SOURCE [3]	SITE TYPE	SAMPLE TYPE [4]	PRIMARY TOOLSTONE REFFERENCES
	WITHIN REGION	OUTSIDE REGION	ACTUAL	HOW LOCAL	GRAND SCALE				
Normanskill chert, from the Mount Merino Formation in eastern New York	Bull Brook, MA		~200	Regionally local	0-500	From N-NW	Camp	Sample 1 (M)	Robinson *et al* (2009) Funk (2004)
	Shawnee-Minisink, PA		240	Regionally local	0-500	From N-NE	Camp	Sample 1 (M)	Gingerich (2011, 2013c)
	Vail, ME		400	Semi-long-distance	0-500	From S-SW	Kill /Camp	Sample 1 (M)	Gramly (2009)
Munsungun chert, from the Munsungan Lake Formation in northern Maine	Bull Brook, MA		450	Semi-long-distance	0-500	From N-NE	Camp	Sample 1 (M)	Pollock *et al.* (1999)
	Plenge, NJ		800	Long-distance	>500	From N-NE	Camp	Sample 1 (M)	Pollock *et al.* (1999)
	Vail, ME		~320	Semi-long-distance	0-500	From N-NE	Kill /Camp	Sample 1 (M)	Pollock *et al.* (1999)
Hardyston jasper, primary outcrop in the Hardyston Formation in eastern Pennsylvania	Bull Brook, MA		450	Semi-long-distance	0-500	From S-SW	Camp	Sample 1 (M)	Hatch (1993)
Hardyston jasper, secondary outcrop in the Hardyston Formation that extends into New Jersey	Plenge, NJ		<25	Very local	0-500	General	Camp	Sample 1 (M)	Kraft (1993) Gingerich (2013b)
New Hampshire spherulitic rhyolite from the northern area of New Hampshire	Bull Brook, MA		200	Regionally local	0-500	From N-NW	Camp	Sample 1 (M)	Pollock *et al.* (2008)
Minas Basin chalcedony, northwest Nova Scotia	Debert, CAN		50-75	Local	0-500	From W-SW	Kill	Sample 1 (M)	MacDonald (1968)
Silicified sandstone or siltstone, from Bay of Fundy in northwest Nova Scotia	Debert, CAN		<100	Local	0-500	From W-SW	Kill	Sample 1 (M)	MacDonald (1968)
Porphyritic rhyolite from Nova Scotia	Debert, CAN		<50	Very local	0-500	General	Kill	Sample 1 (M)	MacDonald (1968)
Onondaga chert, primary outcrops in western New York	Plenge, NJ		250	Semi-long-distance	0-500	From N	Camp	Sample 1 (M)	Gingerich (2013b)
	Shawnee-Minisink, PA		160	Regionally local	0-500	From N-NE	Camp	Sample 1 (M)	Gingerich (2011, 2013c)
	Shoop, PA		350	Semi-long-distance	0-500	From N	Kill / Camp	Sample 1 (M)	Carr *et al.* (2013a)
		Williamson, VA	800	Long-distance	>500	From N-NW	Workshop	Sample 3 (S)	Peck (2004)
Houserville jasper, probably from a sandstone quarry in central Pennsylvania	Shoop, PA		160	Regionally local	0-500	From SW	Kill / Camp	Sample 1 (M)	Carr *et al.* (2013a)
Vera Cruz jasper, from a sandstone quarry in the Hardyston Formation, Pennsylvania	Shoop, PA		125	Regionally local	0-500	From SW	Kill / Camp	Sample 1 (M)	Carr *et al.* (2013a)
	Vail, ME		>700	Long-distance	>500	From S-SW	Kill / Camp	Sample 1 (M)	Gramly (2009)
Normanskill chert from the Hudson River Lowlands in southeast New York	Sugarloaf, MA		100	Regionally local	0-500	From W	Camp	Sample 3 (S)	Gramly (2014)

Blue Hills felsite, from outcrops in eastern Massachusetts	Sugarloaf, MA		160	Regionally local	0-500	From E-SE	Camp	Sample 3 (S)	Gramly (2014)
Mt. Jasper rhyolite, from a quarry in northern New Hampshire	Sugarloaf, MA		300	Semi-long-distance	0-500	From NE	Camp	Sample 3 (S)	Gramly (2014)

MIDDLE ATLANTIC AND SOUTHEAST REGION **MIDDLE ATLANTIC SUBREGION** Delaware, Maryland, West Virginia, and Virginia)									
RAW MATERIAL TYPE AND SOURCE WITHIN THE REGION*	**SITE NAME AND LOCATION**		**DISTANCE FROM SOURCE (KM) [1, 2]**			**DIRECTION OF SOURCE [3]**	**SITE TYPE**	**SAMPLE TYPE [4]**	**PRIMARY TOOLSTONE REFFERENCES**
	WITHIN REGION	**OUTSIDE REGION**	**ACTUAL**	**HOW LOCAL**	**GRAND SCALE**				
Williamson chert, sometimes called Cattail Creek chalcedony, from a quarry in Virginia	Williamson, VA		0-5	At source	0-500	n/a	Workshop	Sample 3 (S)	McCary (1951) Peck (2004) Stevenson *et al.* (2004)
	Cactus Hill, VA		<20	Very local	0-500	From NW	Camp	Sample 1 (M)	McAvoy and McAvoy (1997)
		Shoop, PA	400	Semi-long-distance	0-500	From S-SE	Kill / Camp	Sample 1 (M)	Peck (2004)
Oolitic quartzite from outcrops in Bertie County, North Carolina	Williamson, VA Cactus Hill, VA		160 <150	Regionally local Regionally local	0-500 0-500	From S-SE From S	Workshop Camp	Sample 3 (S) Sample 1 (M)	Bottoms (1968) Bottoms (1968)
Flint Run jasper, from the Thunderbird Flint Run quarry, Virginia	Williamson, VA		<10	Very local	0-500	General	Workshop	Sample 3 (S)	Peck (2004)
Mitchell chert, main outcrops in a quarry in Virginia	Williamson, VA Cactus Hill, VA		<20 15	Very local Very local	0-500 0-500	General From SW	Workshop Camp	Sample 3 (S) Sample 1 (M)	Peck (2004) McAvoy and McAvoy (1997)
Unnamed dark grey chert in cobble outcrops in Maryland	Camp Pecometh, MD		<100	Local	0-500	General	Isolate	Sample 1 (M)	Lowery (2002)
Iron Hill jasper from the Newark area of Delaware	Meekins Neck, MD		150	Regionally local	0-500	From N-NE	Camp	Sample 2 (C)	Lowery and Phillips (1994)
SOUTHEAST SUBREGION (Alabama, Florida, Georgia, Louisiana, Mississippi, North and South Carolina, Tennessee, Kentucky, and Arkansas)									
Ste. Genevieve chert, cobble outcrops from the Little River, Kentucky, with the main outcrop in Missouri	Adams, KY		0-5	At source	0-500	n/a	Workshop	Sample 3 (S)	Sanders (1990) Gramly and Yahnig (1991)
Dover chert, most likely from the outcrops in Stewart County, Tennessee	Adams, KY		75	Local	0-500	From S-SW	Workshop	Sample 3 (S)	Sanders (1990) Parish (2010)

Paoli chert, primary sources are in Carter County, Kentucky	Big Bone Lick, KY		200	Regionally local	0-500	From E-SE	Kill / Camp	Sample 3 (S)	Tankersley (1985)
Boyle chert, primary outcrops in Boyle County, Kentucky	Big Bone Lick, KY		200	Regionally local	0-500	From S-SE	Kill / Camp	Sample 3 (S)	Tankersley (1985)
Breathitt Flint Ridge chert, found in eastern Kentucky	Big Bone Lick, KY		270	Semi-long-distance	0-500	From E-SE	Kill / Camp	Sample 3 (S)	Tankersley (1985)
Buffalo River chert, a variety of Ft. Payne chert, cobble outcrops along Tennessee River, Tennessee	Carson-Conn-Short, TN		0-5	At source	0-500	n/a	Camp / Workshop	Sample 1 (M)	Broster and Norton (1996a, 1996b) Broster *et al.* (2013)
Unnamed dark greenish grey and tan cherts, sourced from outcrops along the Aucilla River, Florida	Sloth Hole, FL		50-100	Local	0-500	General	Kill / Camp	Sample 1 (M)	Hemmings (2005) Webb (2006)

MIDCONTINENT AND GREAT LAKES (Wisconsin, Minnesota, Missouri, Illinois, Indiana, Ohio, Michigan, and Iowa)									
RAW MATERIAL TYPE AND SOURCE WITHIN THE REGION*	**SITE NAME AND LOCATION**		**DISTANCE FROM SOURCE (KM)** [1,2]			**DIRECTION OF SOURCE** [3]	**SITE TYPE**	**SAMPLE TYPE** [4]	**PRIMARY TOOLSTONE REFFERENCES**
	WITHIN REGION	**OUTSIDE REGION**	**ACTUAL**	**HOW LOCAL**	**GRAND SCALE**				
Burlington chert, from the Mississippian Formation outcrops in the Crescent Hills, Missouri	Kimmswick, MO		7	Very local	0-500	From NW	Kill	Sample 1 (M)	Koldehoff (1983)
Fern Glenn chert, from the Fern Glen Formation outcrops in Missouri	Kimmswick, MO		<60	Local	0-500	From NE	Kill	Sample 1 (M)	Koldehoff (1983)
St. Genevieve chert from a limestone exposure in the Mississippi River Bluff, Missouri	Kimmswick, MO		<60	Local	0-500	From N	Kill	Sample 1 (M)	Koldehoff (1983); Tankersley and Morrow (1993)
Flint Ridge chert / chalcedony outcrops in Licking County, central Ohio.	Paleo Crossing, OH	 Lamb, NY Big Bone Lick, KY	<200 550 250	Regionally local Long-distance Semi-long-distance	0-500 >500 0-500	From S From W-SW From E-NE	Camp Camp Kill / Camp	Sample 1 (M) Sample 1 (M) Sample 3 (S)	Boulanger *et al.* (2015) Gramly (1988a) Tankersley (1985)
Upper Mercer chert outcrops primarily in Coshocton County, central Ohio	Paleo Crossing, OH	 Lamb, NY Big Bone Lick, KY	120 530 >300	Regionally local Long-distance Semi-long-distance	0-500 >500 0-500	From S From W-SW From E-NE	Camp Camp Kill / Camp	Sample 1 (M) Sample 1 (M) Sample 3 (S)	Boulanger *et al.* (2015) Gramly (1988a) Tankersley (1985)

Wyandotte chert, outcrops in Harrison and Crawford Counties in southern Indiana	Paleo Crossing, OH Sheriden Cave, OH		825 750	Long-distance Long-distance	>500 >500	From W-SW From SW	Camp Kill / Camp	Sample 1 (M) Sample 2 (C)	Boulanger *et al.* (2015) Tankersley and Holland (1994) Tankersley (1997)
Cedarville-Guelph chert, widely available in western Ohio		Big Bone Lick, KY	250	Semi-long-distance	0-500	From E-NE	Kill / Camp	Sample 3 (S)	Tankersley (1985)
Jefferson City chert, nearest outcrops are along the banks of Silver Creek, Missouri	Big Eddy, MO		0-5	Very local	0-500	General	Camp	Sample 3 (S)	Lopinot *et al.* (1998) Ray (1998)
Lower Reeds Spring chert, sources in Stone County, Missouri	Big Eddy, MO		100-120	Regionally local	0-500	From S	Camp	Sample 3 (S)	Ray (1998)
Attica chert, outcrops in west-central Indiana	Mueller-Keck, IL		350	Semi-long-distance	0-500	From NE	Camp	Sample 1 (M)	Koldehoff (1983) Morgan *et al.* (2008)
Holland chert, outcrops in southern Indiana	Mueller-Keck, IL		290	Semi-long-distance	0-500	From E	Camp	Sample 1 (M)	Koldehoff (1983) Morgan *et al*. 2008) Koldehoff and Loebel (2009)
Kaolin chert, outcrops in southeastern Illinois	Bostrom, IL		>150	Regionally local	0-500	From SE	Camp	Sample 2 (C)	Tankersley (1991,1995) Tankersley *et al.* (1993)
Burlington chert, outcrops in Mississippian limestone bedrock in western Illinois, southwest Iowa, and Missouri	Ready / Lincoln Hills, IL Rummells-Maske, IA		0-5 50	Very local Local	0-500 0-500	General From S	Quarry / Camp Camp / Cache	Sample 2 (C) Sample 1 (M)	Morrow (1995) Morrow (1994) Morrow and Morrow (2002)
St. David chert, outcrops in the Carbondale Formation limestone deposits, Illinois	Ready / Lincoln Hills, IL		120	Regionally local	0-500	From S	Quarry / Camp	Sample 2 (C)	Morrow (1995)
Verdi chert, from the St. Louis Formation in southeast Iowa	Rummells-Maske, IA		80	Local	0-500	From S	Camp / Cache	Sample 1 (M)	Morrow (1994) Morrow and Morrow (2002)

NORTHERN PLAINS REGION
(Montana, North and South Dakota, Wyoming, Nebraska, and Colorado)

RAW MATERIAL TYPE AND SOURCE WITHIN THE REGION*	SITE NAME AND LOCATION		DISTANCE FROM SOURCE (KM) [1, 2]			DIRECTION OF SOURCE [3]	SITE TYPE	SAMPLE TYPE [4]	PRIMARY TOOLSTONE REFFERENCES
	WITHIN REGION	OUTSIDE REGION	ACTUAL	HOW LOCAL	GRAND SCALE				
Hartville Formation chert, sources in the Hartville Uplift, Wyoming	Anzick, MT		590	Long-distance	>500	From SE	Cache	Sample 1 (M)	Kilby (2014)
	Hell Gap, WY		<100	Local	0-500	From S	Kill / Camp	Sample 1 (M)	Irwin-Williams *et al.* (1973)
	Dent, CO		270	Semi-long-distance	0-500	From N-NE	Kill	Sample 1 (M)	Holen (2003, 2014)
Moss agate, sources in the Hartville Uplift, Wyoming	Anzick, MT		620	Long-distance	>500	From SE	Cache	Sample 1 (M)	Kilby (2014)
Amsden Formation phosphoria chert, outcrops in the Bighorn Mountains, Wyoming	Anzick, MT		190	Regionally local	0-500	From E-SE	Cache	Sample 1 (M)	Kilby (2014)
	Colby, WY		<100	Local	0-500	From NE	Kill	Sample 1 (M)	Frison and Todd (1986)
	Casper, WY		180	Regionally local	0-500	From N	Kill	Sample 1 (M)	Frison (1974)
	Fenn, UT/WY/!D border		550	Long-distance	>500	From E-NE	Cache	Sample 1 (M)	Kilby (2014)
		Simon, ID	800	Long-distance	>500	From E-NE	Cache	Sample 1 (M)	Kohntopp (2010) Santarone (2014)
Dakota Formation quartzite from along the Missouri River in Nebraska		Jake Bluff, OK	800	Long-distance	>500	From N.NE	Kill	Sample 1 (M)	Bement and Carter (2010)
Madison Formation chert, from the limestone outcrops in northeast Wyoming	Colby, WY		<100	Local	0-500	From NE	Kill	Sample 1 (M)	Frison and Todd (1986)
Spanish Diggings quartzite, from the Hartville Formation, Wyoming	Sheaman, WY		~80	Local	0-500	From SW	Isolate	Sample 1 (M)	Frison (1982) Haynes *et al.* (2004)
Flattop chert, the White River Group Silicate, from Flattop Butte, Colorado	Dent, CO		130	Regionally local	0-500	From E-NE	Kill	Sample 1 (M)	Holen (2003, 2014)
	Klein, CO		~125	Regionally local	0-500	From E-NE	Kill	Sample 1 (M)	Zier *et al.* (1993)
	Fox, CO		~125	Regionally local	0-500	From E-NE	Isolate	Sample 2 (C)	Jepson *et al.* (1994)
		Eckles, KS	450	Semi-long-distance	0-500	From W-NW	Kill / Camp	Sample 1 (M)	Hoard *et al.* (1993)
Laramie Formation chalcedony from the Laramie Mountains in southeast Wyoming	Drake, CO		140	Regionally local	0-500	From NE	Cache	Sample 1 (M)	Stanford and Jodry (1988) Kilby (2014)
Green River Formation chert from outcrops in southwest Wyoming	Fenn, UT/WY/!D border		130	Regionally local	0-500	From SE	Cache	Sample 1 (M)	Kilby (2014)
		Simon, ID	800	Long-distance	>500	From SE	Cache	Sample 1 (M)	Kohntopp (2010) Santarone (2014)
Smoky quartz crystal, possibly from Pikes Peak region of central Colorado	Fenn, UT/WY/!D border		>1000	Extreme long-distance	>500	From SE	Cache	Sample 1 (M)	Kilby (2014)
Knife River Flint (chalcedony) outcrops in west-central North Dakota		Lamb, NY	~2000	Extreme long-distance	>500	From W-NW	Camp	Sample 1 (M)	Gramly (1988a)
		Bostrom, IL	>1500	Extreme long-distance	>500	From NW	Camp	Sample 2 (C)	Tankersley (1991,1995) Tankersley *et al.* (1993)
Minnelusa Formation chert, sources in the Black Hills Uplift, southwest South Dakota	Lange-Fergusson, SD		150	Regionally local	0-500	From NW	Kill	Sample 1 (M)	Hannus (1990)

SOUTHERN PLAINS AND DESERT SOUTHWEST REGION SOUTHERN PLAINS SUBREGION (Kansas, Oklahoma, and Texas)									
RAW MATERIAL TYPE AND SOURCE WITHIN THE REGION*	**SITE NAME AND LOCATION**		**DISTANCE FROM SOURCE (KM) [1, 2]**			**DIRECTION OF SOURCE [3]**	**SITE TYPE**	**SAMPLE TYPE [4]**	**PRIMARY TOOLSTONE REFFERENCES**
	WITHIN REGION	**OUTSIDE REGION**	**ACTUAL**	**HOW LOCAL**	**GRAND SCALE**				
Alibates chert, primary outcrops are along the Canadian River in the Texas panhandle, Texas	Jake Bluff, OK		200	Regionally local	0-500	From SW	Kill	Sample 1 (M)	Bement and Carter (2010); Bement (2014)
	Bull Creek, OK		150	Regionally local	0-500	From S	Kill	Sample 1 (M)	Pusemann (2004)
	Miami, TX		60	Local	0-500	From W	Kill	Sample 1 (M)	Holiday and Welty (1981)
		Drake, CO	580	Long-distance	>500	From S-SE	Cache	Sample 1 (M)	Stanford and Jodry (1988); Kilby (2014)
		Blackwater Draw, NM	~250	Semi-long-distance	0-500	From N-NE	Kill / Camp	Sample 1 (M)	Boldurian and Cotter (1999)
Edwards Plateau chert from limestone outcrops that occur in three primary geologic areas, the Callahan Divide, Fort Hood, and Leon Creek, central Texas	Domebo, OK		>400	Semi-long-distance	0-500	From S	Kill	Sample 1 (M)	Leonhardy and Anderson (1966)
	Lewisville, TX		320	Semi-lon- distance	0-500	From SW	Kill / Camp	Sample 1 (M)	Crook (2013)
	Gault, TX		~100	Regionally local	0-500	From W	Camp	Sample 1 (M)	Speer (2014a, 2014b)
	McFaddin Beach, TX		480	Semi-long-distance	0-500	From NW	Surface	Sample 3 (S)	Patterson (2000)
		Drake, CO	955	Long-distance	>500	From S-SE	Cache	Sample 1 (M)	Stanford and Jodry (1988)
		Blackwater Draw, NM	450	Semi-long-distance	0-500	From SE	Kill / Camp	Sample 1 (M)	Kilby (2014) Boldurian and Cotter (1999)
Lynn Mountain Formation quartzite, sources in the Ouachita Mountains, southeast Oklahoma	Domebo, OK		320	Semi-long-distance	0-500	From E-SE	Kill	Sample 1 (M)	Leonhardy and Anderson (1966)
Tecovas Formation quartzite outcrops are part of the chert outcrops and occur along the Llano Estacado escarpment, Texas	Miami, TX		~200	Regionally local	0-500	From S	Kill	Sample 1 (M)	Quigg *et al.* (2011)
Tecovas Formation jasper comes from the same chert outcrops that occur in the Llano Estacado, Texas		Blackwater Draw, NM	300	Semi-long-distance	0-500	From E-SE	Kill / Camp	Sample 1 (M)	Holliday and Welty (1981) Boldurian and Cotter (1999)
Butterscotch chert, closest sources are in outcrops in the Wylie Mountains, west Texas	North Sulphur River, TX		~950	Long-distance	>500	From W-SW	Isolate	Sample 2 (C)	Slade (2018)

DESERT SOUTHWEST (New Mexico, Arizona, and Sonora)									
Zacualtipan obsidian from outcrops in Hidalgo, southeast Mexico		McFaddin Beach, TX	1500	Extreme long-distance	>500	From SSW	Surface	Sample 3 (S)	Hester *et al.* (1992); Giauque *et al.* 1993)
Jemez obsidian from sources in the Jemez Mountains in northern-central New Mexico	Blackwater Draw, NM Mockingbird Gap, NM		350 ~250	Semi-long-distance Semi-long-distance	0-500 0-500	From NW From NE	Kill / Camp Camp	Sample 1 (M) Sample 3 (S)	Johnson *et al.* (1985); Hamilton *et al.* (2013) Holiday *et al.* (2009)
Chuska Formation chert, from outcrops in the Chuska Mountains on the Arizona, New Mexico border	Mockingbird Gap, NM		~350	Semi-long-distance	0-500	From NW	Camp	Sample 3 (S)	Holiday *et al.* (2009)
Socorro jasper from sources north and west Socorro County, south-central New Mexico	Mockingbird Gap, NM		15	Very local	0-500	General	Camp	Sample 3 (S)	Holiday *et al.* (2009)
China chert, from the northeastern Zuni Mountains in northwestern New Mexico	Mockingbird Gap, NM		190	Regionally Local	0-500	From NW	Camp	Sample 3 (S)	Holiday *et al.* (2009)
St. David Formation chalcedony from the deposits in the eroded badlands, Arizona	Murray Springs, AZ Lehner, AZ Leikem, AZ		~50 ~30 ~30	Local Local Local	0-500 0-500 0-500	From N From N From N	Kill Kill / Camp Isolate / Kill	Sample 1 (M) Sample 1 (M) Sample 1 (M)	Huckell (2007) Haury *et al.* (1959) Johnson and Haynes (1967); Huckell (2007)
Carr Canyon quartz crystal from the Huachuca Mountains in the San Pedro Valley, Arizona	Lehner, AZ		<50	Local	0-500	From W-NW	Kill	Sample 1 (M)	Huckell (2007)
Cow Canyon obsidian sources in east-central Arizona	Murray Springs, AZ		~300	Semi-long-distance	0-500	From NE	Kill / Camp	Sample 1 (M)	Huckell (2007) Shackley (2007)
Petrified wood, the nearest source being in the Mogollon Rim, Arizona	Murray Springs, AZ		~250	Semi-long-distance	0-500	From N	Kill / Camp	Sample 1 (M)	Huckell (2007)
Unnamed pinkish grey, grey to reddish brown cherts, and translucent chalcedony, from the bordering San Pedro Valley mountain limestone outcrops, Arizona	Naco, AZ Lehner, AZ Murray Springs, AZ Escapule, AZ		~25 ~25 ~25 ~25	Very local / Local Very local / Local Very local / Local Very local / Local	0-500 0-500 0-500 0-500	General General General General	Kill Kill Kill / Camp Kill	Sample 1 (M) Sample 1 (M) Sample 1 (M) Sample 1 (M)	Huckell (2007) Huckell (2007) Huckell (2007) Hemmings and Haynes (1969) Huckell (2007)
Unnamed dark grey felsite, from the mountains bordering the San Pedro Valley, Arizona	Naco, AZ		~25	Very local / Local	0-500	General	Kill	Sample 1 (M)	Haury (1953) Huckell (2007)
Unnamed pinkish red and grey chert from nearby eroding river channel deposits, Sonora, Mexico	El Fin del Mundo, MEX		0-5	At source	0-500	General	Kill	Sample 1 (M)	Samchez *et al.* (2014)
Clear quartz crystal from a quarry in the Sonora Desert, northwestern Mexico	El Fin del Mundo, MEX		0-5	At source	0-500	General	Kill	Sample 1 (M)	Samchez *et al.* (2014)

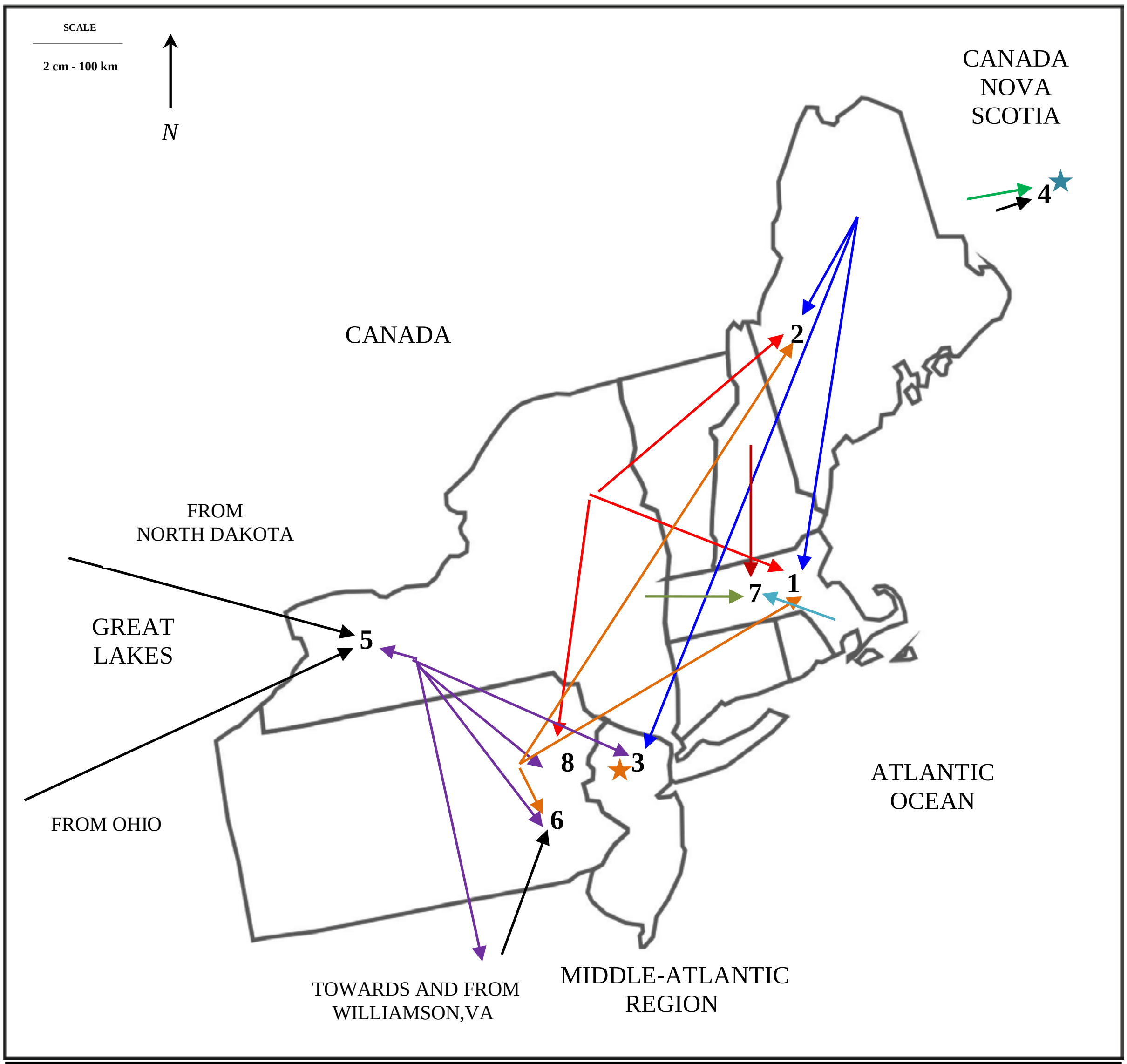
SOUTHWEST AND GREAT BASIN REGION (Great Basin - all of Nevada and part of Utah; Colorado Basin - part of Utah; California areas)									
RAW MATERIAL TYPE AND SOURCE WITHIN THE REGION*	**SITE NAME AND LOCATION**		**DISTANCE FROM SOURCE (KM) [1, 2]**			**DIRECTION OF SOURCE [3]**	**SITE TYPE**	**SAMPLE TYPE [4]**	**PRIMARY TOOLSTONE REFFERENCES**
	WITHIN REGION	**OUTSIDE REGION**	**ACTUAL**	**HOW LOCAL**	**GRAND SCALE**				
Utah agate, several sources in central Utah	Fenn, UT/WY/!D border		350	Semi-long-distance	0-500	From S-SW	Cache	Sample 1 (M)	Kilby (2014)
Wild Horse Canyon obsidian, sourced to outcrops in southwest Utah		Blackwater Draw, NM	~1000	Long-distance / Extreme long-distance	>500	From NW	Kill / Camp	Sample 1 (M)	Nelson and Holmes (1979) Holen (2004)
Borax Lake obsidian, several sources from the Borax Lake area in California	Borax Lake, CA		0-5	At source	0-500	General	Camp	Sample 1 (M)	Kaufman (1978) Frederickson and Origer (2002)
Franciscan chert, from the San Francisco Bay area, California	Borax Lake, CA		~650	Long-distance	>500	From S	Camp	Sample 1 (M)	Rondeau (2004)
Unnamed obsidian sourced in Utah	Dugway Military Proving Ground, UT		NIA	NIA	<500	NIA	Isolate	Sample 1 (M)	Slade (2018)

NORTHWEST REGION (Idaho, Oregon, and Washington)									
RAW MATERIAL TYPE AND SOURCE WITHIN THE REGION*	SITE NAME AND LOCATION		DISTANCE FROM SOURCE (KM) [1, 2]			DIRECTION OF SOURCE [3]	SITE TYPE	SAMPLE TYPE [4]	PRIMARY TOOLSTONE REFFERENCES
	WITHIN REGION	OUTSIDE REGION	ACTUAL	HOW LOCAL	GRAND SCALE				
Malad obsidian, from sources in southeast Idaho	Fenn, UT/WY/!D border		150	Regionally local	0-500	From NW	Cache	Sample 1 (M)	Kilby (2008, 2014)
Glass Butte obsidian, from various sources in Oregon	Dietz, OR		45	Local	0-500	From N	Camp / Surface	Sample 1 (M)	Willig (1988) Pinson (2008, 2011)
Unnamed obsidian from sources in northern Oregon	Hoyt, OR		~100	Regionally local	0-500	General	Camp / Surface	Sample 1 (M)	Pinson (2008, 2011) Rondeau (2009a, 2009c)
Ephrata Formation agate, semi-translucent whitish grey, and reddish brown varieties, from Washington	East Wenatchee, WA		50	local	0-500	From W	Cache	Sample 1 (M)	Gramly (1993) Kilby (2014)
Rainbow greenish black obsidian, from outcrops in the Warner Mountains, northeastern California and southern Oregon	Badger Mountain, WA		~700	Long-distance	>500	From S	Isolate	Sample 1 (M)	Mehringer (1988) Gramly (1993)

[1] *Distance from source as laid out in my parameters in Table. 4.1*
[2] *0-500 km from within the region, and greater than 500 km from outside the region*
[3] *Direction of the raw material sources in relation to the site or findspot of point*
[4] *Samples 1-3 as defined in Chapter 3: M= Main, Sample 1; C= Comparative, Sample 2; and S= Supporting, Sample 3*

Identified distances from toolstone source to Clovis point findspot were taken from published sources. In some cases approximate distances were calculated when closest available source was published but no definite distance was recorded, and if known the direction of the toolstone to findspot. Region boundaries as set out in previous chapters in this thesis.

Table. 4.2 Lithic raw materials, sources, distances and directions from the source to findspot of the Clovis points that make up my samples M, C, and S: See also regional maps (Figures. 4.1 to 4.7)



SITES [1]	**RAW MATERIALS** [2]
1. Bull Brook, MA	* Normanskill chert - Mount Merino Formation
2. Vail, ME	* Munsungun chert - Munsungan Lake Formation
3. Plenge, NJ	* Hardyston jasper and Vera Cruz jasper - Hardyston Formation
4. Debert, Nova Scotia, CAN	* Onondaga chert - Onondaga Formation
5. Lamb, NY	* Normanskill chert - Hudson River Lowlands
6. Shoop, PA	* Blue Hills felsite
7. Sugarloaf, MA	* Mt. Jasper rhyolite
8. Shawnee-Minisink, PA	* Minas Basin chalcedony
	* Bay of Fundy siltstone
	* Unnamed porphyritic rhyolite

[1] *All the sites on the map are included in the main raw material breakdown: Table. 4.2*
[2] *Only the main toolstone types from Table. 4.2 are included in the regional map: Figure. 4.1*

Stars on the map indicate raw material sources from within the general area of the site, arrows indicate general distance of the source

Figure. 4.1 Map of the Clovis-aged sites from the Northeast region, and the main toolstone types and their sources that are present in the assemblage. See Table. 4.2

4.2.1 Region 1: Northeast

Paleoindian research in the northeast of North America is conventionally known for having distinctive point types, long distance movement of good quality lithic raw materials, and intrasite spatial patterning, that provides a unique insight into aspects of cultural mobility and social organisation among low-density populations on the Pleistocene landscape. Large Clovis-aged campsites in this region attracted much attention in the late 1990s as potential aggregation locations (*e.g*. Dincauze 1993a; Spiess *et al.* 1998; Curran 1999; Ellis and Deller 2000), and the largest of these sites, Bull Brook, Massachusetts, has been the subject of a reinvestigation of the major Paleoindian sites in the region (Gingerich 2013a, 2018; Robinson and Ort 2013; Lothrop *et al.* 2016).

Based on visual identification and a comparative analysis on geological reference collections it was confidently reported (Robinson *et al.* 2009) that the majority of the Bull Brook toolstone came from at least 200 km away and could be classified as regionally local by my distance parameters (Table. 4.2). None of the truly 'exotic' - extreme long-distance materials, that have been identified in other assemblages in this region, such as Knife River Flint are present at the site (see Tankersley 1991).

At the Sugarloaf site in Massachusetts the chert present is visually similar to another raw material, known as Hathaway chert, from the Vermont Champlain Lowlands that might also have been the source of the toolstone present in the site's assemblage. Due to the Champlain Sea flooding (Robinson 2012); the outcrops of the Hathaway chert around the time of the first Clovis groups in the area, these sources were likely not available to the Sugarloaf flintknappers (see Mason 1960; Bradley 1998; Robinson 2012). The Mt. Jasper source could have been accessed during the summer season when the Sugarloaf Clovis groups followed herds of caribou bound for the northern calving grounds. Studies of modern caribou herds in northern Canada indicate distances between winter feeding and calving grounds range from 100 to 350 km (*e.g.* Gordon 1975), interesting to note, that a straight-line distance between the Sugarloaf site and the Mt. Jasper outcrops is 225 km, which is well within the figure of seasonal movements.

The Vail site in Oxford County, northwestern Maine, is another large Clovis-aged campsite, which also has a kill site component (Gramly 1984, 2009). The fluted point assemblage is dominated by Normanskill chert that comes from the Hudson Valley in New York, over 400 km away. The two other materials present are a yellow jasper, most likely the Vera Cruz variety from Pennsylvania, sourced from over 600 km away, and a chert that has been identified as most likely being Munsungun chert, which represents the most local of the toolstone present (Table. 4.2). The fluted points from Vail represent a Clovis variant; they have a very distinctive deep v-shaped basal concavity. Although the points have gone through a series of modification and reworking, a few key characteristics survive, and the deep basal concavity usually remains unscathed.

Clovis hunter-gatherer groups present at some Pennsylvanian campsites, *e.g.* Shoop and Shawnee-Minisink, seem to have brought in their own toolstone whilst ignoring more local materials. This could be evidence of groups following the caribou herds on annual migrations. At the Shoop site the majority of the points were made on Onondaga chert, which is not local and was brought in from outside the area and transported within the group in the form of small nodules or cobbles (Cox 1986). The debitage from point maintenance that was present in the Shoop assemblages, supports this, as only the debitage of the toolstone brought with them is present. However, the primary toolstone used at the Shawnee-Minisink site was an unnamed black chert that came from quarry sources only 1 km away, and the non-local material from sources only 5 km away. This material was termed as non-local in the literature to distinguish it from the closer material (Gingerich 2013c).

At Plenge in New Jersey the suggestion made at the Shoop site is repeated, with perhaps the surprising absence of high-quality very local toolstone, the Helderberg and Shriver chert outcrops are located less than 50 km away, and were not present in the assemblage. Apart from the jasper that most likely came from the Hardyston quartzite formation less than 25 km from the site (Table. 4.2), the toolstone that the majority of fluted points were made from were non-local materials. Munsungan chert had outcrops in Maine (Pollock *et al.* 1999) and Onondaga outcrops in New York (Eisenberg 1978).

The Lamb site in western New York represents another site where the more local raw material, Onondaga chert, was either ignored or not needed. The toolstone only appears in very small quantities, whereas the predominant materials are made from Flint Ridge chert / chalcedony from central Ohio, Upper Mercer chert, also from central Ohio, and Knife River Flint, a chalcedony from west-central North Dakota [13]. All three toolstone types represent long distance and extreme long distance movement of lithic material (Gramly 2012), and if the Clovis point spec # 98/101 (LAM 01) is in fact made on Knife River Flint, it would represent a straight-line distance of at least 2000 km.

Lamb might reveal more about landscape usage and raw material sourcing than hypothesising about mobility strategies on early Paleoindian in the northeastern region and percentages of non-local toolstone (Gingerich 2013b), and could be a reflection of what was occurring at Shoop, where these groups were unfamiliar with sourcing local toolstone. If this were the case, then these groups at Shoop and Plenge, and probably other sites in this region, could represent colonising groups, visiting the region for the first time, or passing through following herds of caribou / deer, and were unaware of the local toolstone available. Whereas

[13] It is very possible that the Knife River Flint toolstone could have been confused with similar materials that were considerably closer - i.e. Hudson Bay Lowland chert, Kaolin chert, Vanport chert, or Cattail Creek chalcedony (Gramly 2012)

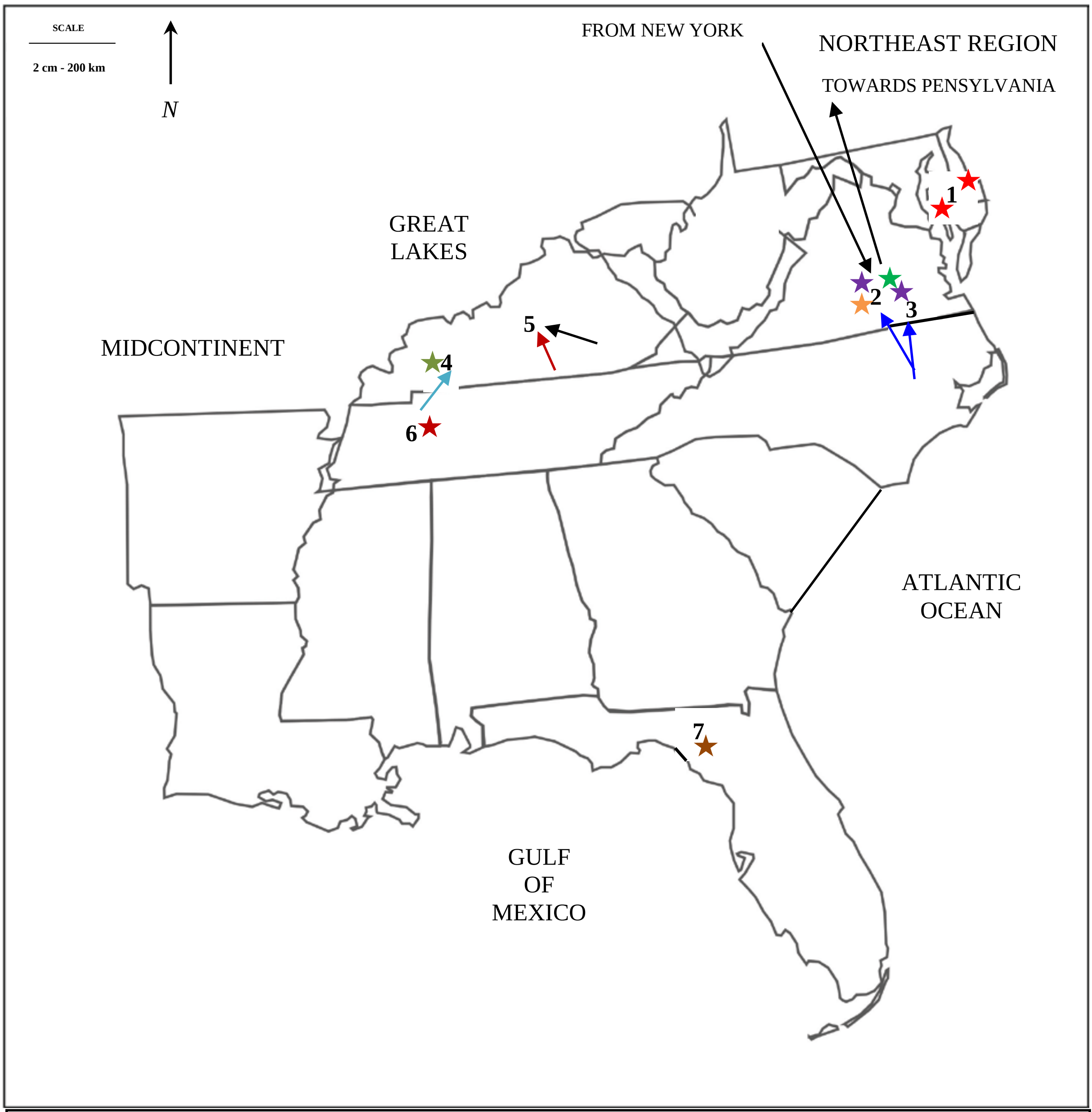
the evidence at Shawnee-Minisink suggests visits by a seasoned group who were familiar with the landscape (Dent 1985; McNett 1985a).

I suggest that there were not only two activities taking place here in this region; where one set of Clovis groups came in and ignored the lithic resources available to them, and others who knew the landscape and exploited these resources. But also during the period that covered Clovis, groups that first got here already had Clovis points made from toolstone from whence they came, and did not require points to be produced, albeit not at first. The evidence of this comes from the analysis on the origin of the toolstone that the fluted points were made on, and the debitage recovered from the site, that revealed whether there was any of that particular toolstone present in the lithic remains.

4.2.2 Region 2: Middle-Atlantic and Southeast

In Chapter 2, I separated this region into two subregions; the Middle-Atlantic and the Southeast, and I see no reason not to review the raw materials used to produce the Clovis points here as two separate areas as well.

There is very little in the archaeological literature that concentrates on lithic sourcing and toolstone resources from the Middle-Atlantic and Southeast subregions (*e.g.* Custer *et al.* 1983; Ellis and Lothrop 1989; Anderson and Sassaman 1996; Gingerich 2013, 2018, but also see Martin-Siebert 2004), the Martin-Siebert overview and the Gingerich volumes are the only studies at present that encompasses the whole region. Other, more focussed, research concentrates on particular sites, but the amount of publications looking at the bigger picture is less than the archaeological record from this region merits (Anderson 2013b).



SITES [1]

1. Delmarva Sites: Camp Pecometh , MD; Meekins Neck, MD
2. Williamson, VA
3. Cactus Hill, VA
4. Adams, KY
5. Big Bone Lick, KY
6. Carson-Conn-Short, TN
7. Aucilla River Sites: Sloth Hole, FL

RAW MATERIALS [2]

* Unnamed dark grey chert, and jasper
* Williamson chert
* Oolitic quartzite
* Flint Run Jasper
* Mitchell chert
* Ste. Genevieve chert
* Dover chert
* Boyle, Breathitt, and Ft. Payne cherts
* Paoli chert
* Unnamed greenish grey and tan Aucilla River cherts

[1] *All the sites on the map are included in the main raw material breakdown: Table. 4.2*
[2] *Only the main toolstone types from Table. 4.2 are included in the regional map: Figure. 4.2*

Stars indicate raw material sources from within the general area of the site, arrows indicate general distance of the source

Figure. 4.2 Map of the Clovis-aged sites from the Middle-Atlantic and Southeast region discussed above, and the main toolstone types and their sources that are present in the assemblage. See also Table. 4.2

Middle-Atlantic subregion

The sample of Clovis points from well-stratified Clovis-aged sites from the two subregions from this region is relatively small when compared to the Northeast region. The Middle-Atlantic region contains at least two large quarry / workshops. Williamson is a large quarry / workshop (McCary 1951; McAvoy 1992; Hill 1997) that has been has been described as the largest early Paleoindian workshop in North America (Peck 2004). The site has extensive outcrops of the Williamson chert, and other very local, local and regionally local cherts (Table. 2.1). It lies on a hillside and upland area adjacent to Little Cattail Creek that has sources of good quality Cattail Creek chalcedony, sometimes referred to as Williamson chert (Callahan 1979; Stevenson *et al.* 2004).

The presence of Onondaga chert in the toolstone assemblage could suggest that there was contact with the Shoop site in Pennsylvania, and it is possible that the jasper that was found at Shoop and Williamson, may have come from the Flint Run jasper quarry that the Thunderbird material was made from. Also, Cattail Creek chalcedony has been reported to be present at the Shoop site (Peck 2004).

An important observation made during my review of the raw materials from Delaware and Maryland, and in particular identifying the toolstone from semi-long, long, and extreme long distance ranges from other regions, was that some Paleoindian archaeologists in the past have felt that they can identify by sight alone certain raw materials, and attribute the variety to long distance movement and trade associations, when it is just as likely the toolstone is far more local (see Spielbauer 1984; Calegoro 1992; Ferguson 1992). However, there are problems in the methodology associated with visual identification of raw materials (see Luedtke 1978, 1979,1992; Butler 1984; Odell 1984; Andrefsky 2012; Cooper 2012), nevertheless, the discussion on the reliability of this widely used method continues to be relevant (Andrefsky 2012). In their paper Parish and Durham (2015:80), conclude that *"the current state of visual chert type identification methodology is potentially flawed"* and suggest an *"awareness of the visual variability across a broad geographic region may lead to more regional surveys and large sample type collections"*. Only then can lithic raw material analysis can fully utilise the resource potential of the toolstone data available (*e.g.* Anderson and Horgen 2006).

Examination of artefacts for cortex and the remnants of weathered surfaces becomes a crucial element in the analysis. One example is that rhyolite does not exist naturally in cobble deposits, therefore rhyolite artefacts discovered on the Delmarva Peninsula are definitely non-local (Custer and Galasso 1980). However, there are rhyolite quarries in Maryland (Stewart 1987).

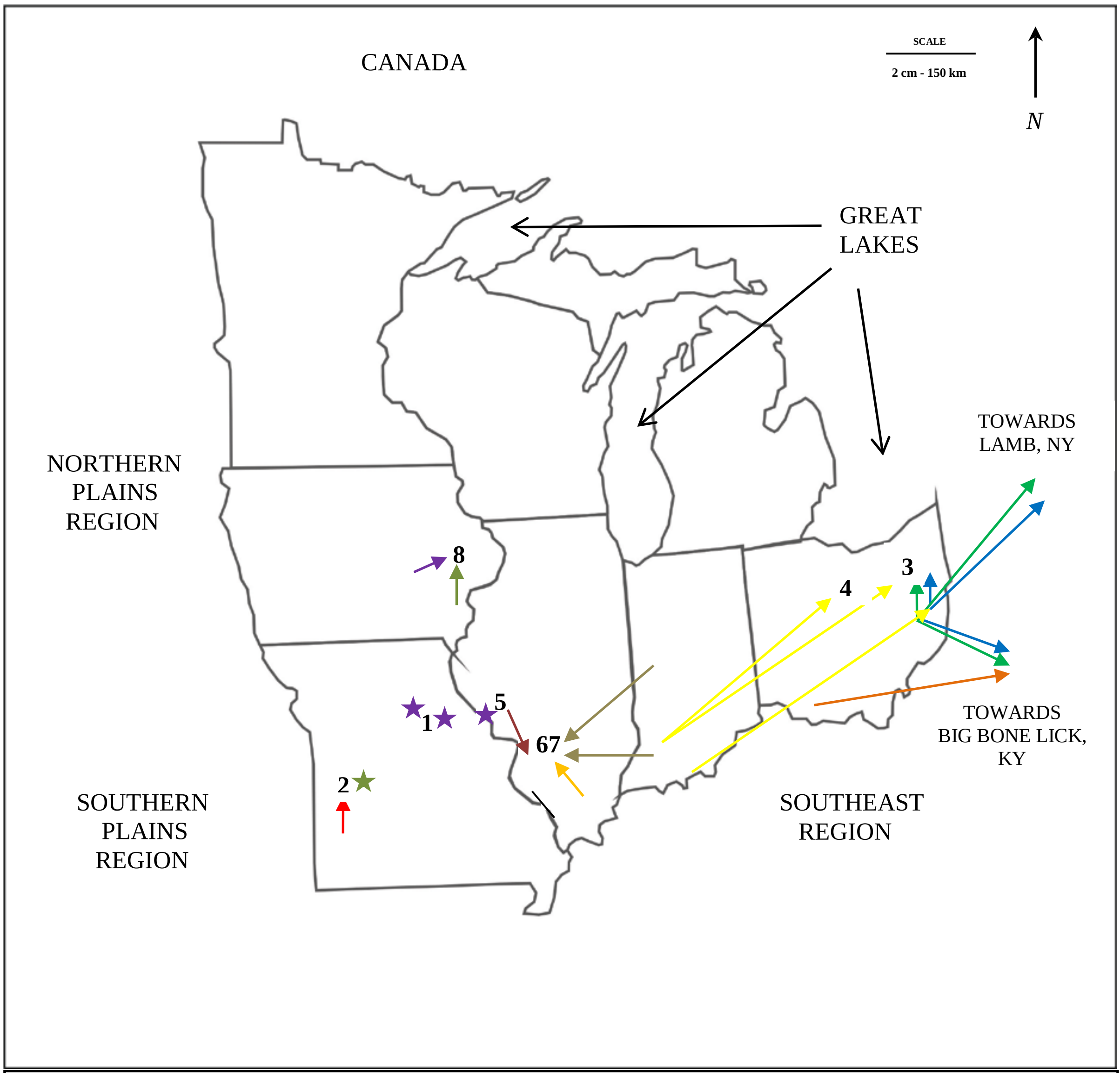
Southeast subregion

The Southeast subregion is loosely bordered to the north by the Ohio and Potomac Rivers, to the west the Mississippi River, and areas to the west, and on the south and east by the Gulf of Mexico and the Atlantic Ocean (Anderson *et al.* 2015). Changes in sea-level, drainage, vegetation and faunal populations in this region were considerable during the late Pleistocene, and would have significantly influenced human movement and settlement. Movement along as well as across river courses in low-lying areas and along larger drainage systems by following tributaries could have been achieved (*e.g.* Anderson 1990b; Steele *et al.* 1998; Anderson and Gillam 2000; Jodry 2005; Brooks *et al.* 2010; Morrow 2014a). The movement of early groups along or between the larger river systems has been at the centre of debate; along the south Atlantic seaboard (see Anderson 1996; Daniel 2001), and on the Florida peninsula (see Dunbar and Walker 1983; Dunbar 1991). There is no direct evidence that Clovis-aged groups used watercraft as a means of transport in this region. Occurrences of identifiable lithic materials on Clovis tools indicated that unfrozen sections of the southern stretches of Mississippi River were not crossed, given the extent of usable toolstone in the central and southern areas of the valley. In contrast were the northern stretches, where movement of raw material was more commonly attributed to the river freezing over, and becoming more accessible on foot (see Morrow 2014a). Similarly, lithic raw materials and site distribution patterns, suggest the Appalachian Mountains were also a major barrier to the movement of peoples and could have separated Clovis-aged groups living along the Atlantic seaboard from those further west (*e.g.* Williams and Stoltman 1965:674; Lane and Anderson 2001). To the south, movement through the Coastal Plain and Piedmont area appears to have much easier (*e.g.* Anderson 1990b; Daniel 2001; Lane and Anderson 2001; Smallwood *et al.* 2015).

In Kentucky, the Adams site has a full range of Clovis fluted point production made from predominantly one toolstone type. Ste. Genevieve chert is available in abundant quantities and occurs in the outcrops of the Little River as large spherical nodules, some as large as 40 cm in diameter, and comes in various shades of bluish-grey (Sanders 1990). The material is also present in the other Little River Clovis Complex sites in the area (Yahnig 1990).

Research into raw material sourcing and availability in the Southeast region has had considerable attention in recent decades (see Anderson *et al* 2015). The use of high-quality non-local exotic raw material is commonly attributed to Clovis (*e.g.* Goodyear 1979, 1989), the use of more locally-available toolstone, regardless of quality is also evident (Anderson 2013b), perhaps related to a reduced range in mobility, changes in subsistence strategies or a decreased use or desire of highly curated tools (Anderson 1990b; Goodyear *et al.* 1990; Anderson *et al.* 2010; Speth *et al.* 2013; Smallwood *et al.* 2015). As in the Middle-Atlantic subregion above, lithic raw material was key in early Paleoindian settlement. Clovis-aged groups exploited toolstone from quarries and lived nearby at base camps for some of the year, returning after their scheduled forays and temporary habitation elsewhere (*e.g.* Gardner 1981).

The two Clovis fluted points from the Sloth Hole site in Florida are made on a dark grey and a tan chert, and both specimens are waisted Clovis variants typical from the Southeast region. There is a wide range of point styles or variants present in the southeast, made on a variety of lithic raw materials, and possibly provide a good comparative dataset and offering a useful record of raw material sources and occurrences in the subregion and region as a whole.



SITES [1]

1. Kimmswick, MO
2. Big Eddy. MO
3. Paleo Crossing, OH
4. Sheriden Cave, OH
5. Ready / Lincoln Hills, IL
6. Mueller-Keck, IL
7. Bostrom, IL
8. Rummells-Maske, IA

RAW MATERIALS [2]

* Burlington, Fern Glen, and Ste. Genevieve cherts
* Lower Reeds Spring chert
* Jefferson City chert
* Flint Ridge chert / chalcedony
* Upper Mercer chert
* Cedarville-Guelph chert
* Wyandotte chert
* Verdi chert
* Attica and Holland cherts
* Kaolin chert
* St. David chert

[1] *All the sites on the map are included in the main raw material breakdown: Table. 4.2*
[2] *Only the main toolstone types from Table. 4.2 are included in the regional map: Figure. 4.3*

Stars indicate raw material sources from within the general area of the site, arrows indicate general distance of the source

Figure. 4.3 Map of the Clovis-aged sites from the Midcontinent and Great Lakes region discussed above, and the main toolstone types and their sources that are present in the assemblage. See also Table. 4.2

4.2.3 Region 3: Midcontinent and Great Lakes

The Clovis sites that made up my sample in this region came from various states and are represented by all the different site types, including a large number of isolated / surface-collected examples, which provide a useful comparative guide as in the region above (Table. 3.2).The sites that are directly related to my analysis and make up the complete sample are listed above (Table. 4.1).

In eastern Missouri the Kimmswick mastodon kill site represents one of the first associations of mastodon and Clovis discovered in North America (Graham *et al.* 1981). The Clovis points were made on local cherts occurring within 60 km of the site (Koldehoff 1983). Based on the data available, it can therefore be suggested that the Kimmswick site offered a combination of local good quality cherts available within a day or two of the site, aquatic resources, and a high overview of an area that attracted game. As this is a kill site with some processing activities, it is also possible that the group were just passing and took advantage of the fact that the site was attractive to extinct megafauna as well as humans (Tankersley and Morrow 1993).

Another Missouri site is Big Eddy from Cedar County (Lopinot *et al.* 1998; Ray *et al.* 1998). The Clovis component at the site contains fluted points, preforms and other lithics made from a local toolstone called Jefferson City chert, although there is a fluted point made on an exotic called Lower Reeds Spring chert (Ray 1998). The closest Jefferson City chert outcrops occur along the lower stretch of Silver Creek, 2-3 km away, and along the base of a ridge less than 5 km of the site (Ray 1998:226). The closest Lower Reeds Spring chert source is in northern Stone County, Missouri, 100 km away, with more abundant sources over 120 km (Ray 1998:228), (Tables. 4.1, 4.2).

In Illinois, Mueller-Keck is two separate surface-collected campsite assemblages located about 1 km apart. The predominant raw material present is Attica chert which has its source over 350 km away in west-central Indiana. It makes up nearly 88% of the assemblage at Mueller, and 98% from Keck. The secondary material is Holland chert, and, although significantly less abundant, also has sources in southwestern Indiana. The overwhelming abundance of semi-long distance material at both locales indicates a relationship between the two despite being separate, and also suggests substantial movement across the region and indicates a relationship of lithic procurement to settlement and subsistence strategies (see Seeman 1994). Although it has been suggested that the difference in quantities of the two toolstone types, indicates a smaller Clovis group travelling from the Holland source area joining a larger group coming from the Attica quarry (Morgan *et al.* 2008).

The Bostrom site, a campsite in Illinois, has an artefact possibly made from Knife River Flint (Tankersley and Morrow 1993; Tankersley 1995). If correct, this would represent an extreme long distance movement of an artefact (Table. 4.2). As it is an item of the Clovis small tool-kit, it is most likely to have been carried around by an individual until it was discarded at the campsite, but it is good evidence of the movement of Clovis groups (Tankersley and Morrow 1993). Like other Clovis-aged sites not directly related to toolstone procurement in mid-western North America (see Tankersley 1989a,1990b), the Bostrom site lithic assemblage is dominated by non-local toolstone, Burlington chert is the closest raw material, which outcrops less than 60 km from the site, but was mainly ignored by the Clovis group; just one blade is present made on this material (Tankersley *et al.* 1993a:52). As acquisition of good quality toolstone was not the reason for Clovis groups being at the site, and it was not a single band simply passing by, as documented by the artefact assemblages, it suggests that Bostrom was occupied intermittently by at least three successive groups of Paleoindians: Clovis-Gainey, Holcombe, and Dalton (Tankersley *et al.* 1993a).

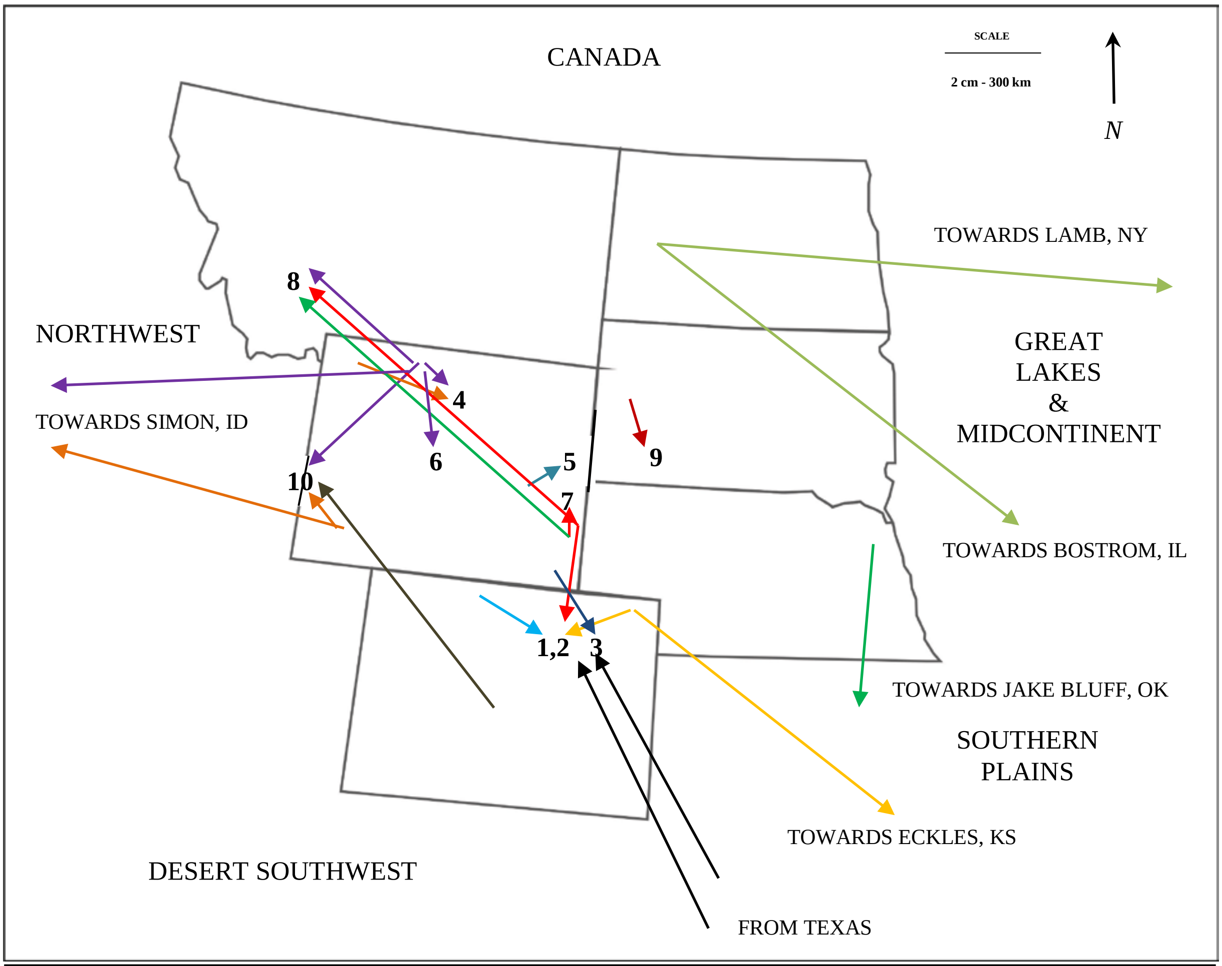
Paleo Crossing is a Clovis campsite in northeast Ohio (Table. 4.1), and perhaps represents extreme long distance movement of toolstone (Boulanger *et al.* 2015). The majority of the Paleo Crossing lithic assemblage is made up of over 80% Wyandotte chert (Tankersley and Holland 1994), that has its closest source in south-central Indiana and northwestern Kentucky (Table. 4.2). This is a straight-line distance of between 450 and 510 km. The other raw materials present in the Clovis assemblage are consistent with sources located less than 200 km from the site (Table. 4.2), such as Flint Ridge chert and Upper Mercer chert whose sources are both less than 200 km away in southern Ohio (Brose 1994; Tankersley and Holland 1994; Eren and Redmond 2009; Boulanger *et al.* 2015). The long distance source-to-site proposal is a minimum estimate of acquisition as Clovis groups did not travel in straight lines (Meltzer 2009). A more realistic extreme long distance is proposed based on two routes, the first a least-cost path incorporating slope and the second is a river route. The actual distance is then more likely approx 825 km for the slope-upland route, while it could be as much as 1200 km following the river routes (Boulanger *et al.* 2015). Interestingly one of the other suggested toolstone types present in the lithic assemblage, Flint Ridge chert, has its closest source located approximately 140 km south of the site. If this material was collected along the journey between the source of the Wyandotte chert and Paleo Crossing, a scenario where Clovis foragers were stopping off and replenishing their toolstone supply, rather than replacing it with a newer encountered raw material would be consistent (Brantingham 2006). But, it is also possible that the Flint Ridge toolstone was procured by a foraging foray after the Clovis group arrived at Paleo Crossing (Morgan *et al.* 2014), or that the toolstone arrived at the site indirectly by intermediaries (*e.g.* Speth *et al.* 2013).

In relation to the direct acquisition model, the Sheriden Cave site in Wyandot County Ohio, is close to the least-cost path between the Wyandotte chert source and Paleo Crossing.

Sheriden Cave yielded artefacts including a Clovis fluted point and a blank preform that have been interpreted as a possible cache (Redmond and Tankersley 2005). Interestingly the dates of Sheriden Cave 10,915 ± 30 ^{14}C yr BP and those of Paleo Crossing 10,980 ± 75 ^{14}C yr BP (Waters *et al* 2009), are very similar (Table. 2.2), plus the toolstone from the Sheriden Cave site is visually identical to Wyandotte chert. The implications of this, and other cases of potential misidentification of lithic raw materials will be discussed below.

It is also worthy of mention that another Clovis site, the closest to Paleo Crossing at less than 50 km to the southeast, and one of the largest in North America, Nobles Pond (33ST357) in Stark County, has nearly half its toolstone visually consistent with Flint Ridge chert (Seeman 1994), and also has Wyandotte chert present in smaller quantities (Seeman *et al.* 2013). Although not suggesting that these three sites are necessarily connected, it is true that whilst all three exhibit primarily the Wyandotte chert and in lesser amounts Flint Ridge chert, the raw material is consistent with stone exchange to some extent. This scenario is also almost identical to the pattern seen in the sites reviewed above in the Northeast Region.

A large proportion of the Clovis fluted point occurrences in this region come from isolates or surface-collected locations, and twenty-three specimens make up my comparative sample (Figure. 3.3; Tables. 3.3; 5.1). The isolates and surface-collected points come from all over the region; Illinois, Indiana, Iowa, Michigan, Missouri, and Ohio. The lithic raw materials used to produce these points are consistent with those from the site assemblages that make up my main sample in this region. The most common material being Burlington and Kaolin cherts, with examples of Upper Mercer, Cobden-Dongola, and other cherts that can all be classified as being regionally local, or closer i.e. <250 km away. The semi-long distance, long distance and extreme long distance materials are also consistent with my main sample, including a Clovis fluted point from Woodbury County, Iowa, that is made from Knife River Flint from North Dakota, some 650 km to the northwest.



SITES [1]	**RAW MATERIAL** [2]
1 Dent, CO	* Hartville chert
2 Kersey Terrace Sites, CO (Klein, Fox etc)	* Hartville moss agate
3 Drake, CO	* Amsden chert
4 Colby, WY	* Madison chert
5 Sheaman, WY	* Spanish Diggings quartzite
6 Casper, WY	* Flattop chert
7 Hell Gap, WY (vicinity of)	* Laramie chalcedony
8 Anzick, MT	* Green River chert
9 Lange-Fergusson, SD	* Smoky quartz crystal
10 Fenn [3], UT, WY, ID	* Knife River Flint chalcedony
	* Minnelusa chert

[1] All the sites on the map are included in the main raw material breakdown: Table. 4.2
[2] Only the main toolstone types from Table. 4.2 are included in the regional map: Figure. 4.4
[3] Included Fenn as there is uncertainty of the exact location, but is believed to be somewhere along the Utah / Wyoming / Idaho border

Figure. 4.4 Map of the Clovis-aged sites from the Northern Plains region discussed above, and the main toolstone types and their sources that are present in the assemblage. See also Table. 4.2

4.2.4 Region 4: Northern Plains

As discussed in Chapter 2, this study area includes the states of Montana, North and South Dakota, Wyoming, Nebraska, and Colorado. The Northern Plains contains relatively well-known lithic raw material sources that are macroscopically distinct and are separated by large areas with little or no lithic resources (Holen 2014), which makes the tracking of Clovis group movement via lithic use reasonably accurate. Vast areas with very little, or only poor quality toolstone required mobile hunter-gather groups to carry large quantities of good quality lithic material with them. Caching the lithic materials provided the group with a resource when they passed through at a later time and raw material supply was low. Some of the caches that had assemblages included in my analysis are discussed below, along with their associated lithic raw materials. Regional studies of Clovis raw material procurement have been carried out in the Northern Plains (*e.g.* Frison 1978; Miller 1991, 2010; Holen 2001), and more general models on a continental scale (*e.g.* Kelly and Todd 1988; Bonnichsen and Turmire 1991; Meltzer 1993, 2009; Haynes 2002). Prior to the work of Holen (*e.g.* 2001), the only published account that covered Clovis procurement strategies was in a brief study of central Great Plains (Greiser 1985).

The toolstone used to produce the points at the Anzick site in Montana were all from northwestern sources in Wyoming (Francis 1991). Hartville chert, Amsden phosphoria chert and Moss agate, all representing long distance movement of around 600 km (Figure. 4.4; Table. 4.2). Based upon the presence of these materials, and the porcellanite which has its source in Montana, patterns of movement across the landscape can be plotted. A route leading northeast from the Bighorn Mountains (Phosphoria chert source) to the Powder River Basin (porcellanite), then southward to the Hartville Uplift (Hartville chert and Moss agate sources), returning to the Anzick location where the materials were finally cached.

The Drake cache in Colorado has thirteen complete Clovis points. Eleven were produced on varieties of Texas Alibates chert that its source over 550 km away in the Texas Panhandle. One of the others, spec #5LO24-07 (DRK 07), was produced on Edwards Plateau chert from over 900 km away in central Texas, and the third 5LO24-13 (DRK 13) on possibly Laramie Formation chalcedony from the Laramie Mountains in southeast Wyoming (Stanford and Jodry 1988; Kilby 2014a).The presence of the Alibates and Edwards chert indicates a long distance movement of high quality materials to the northwest (Figure. 4.4; Table. 4.2).

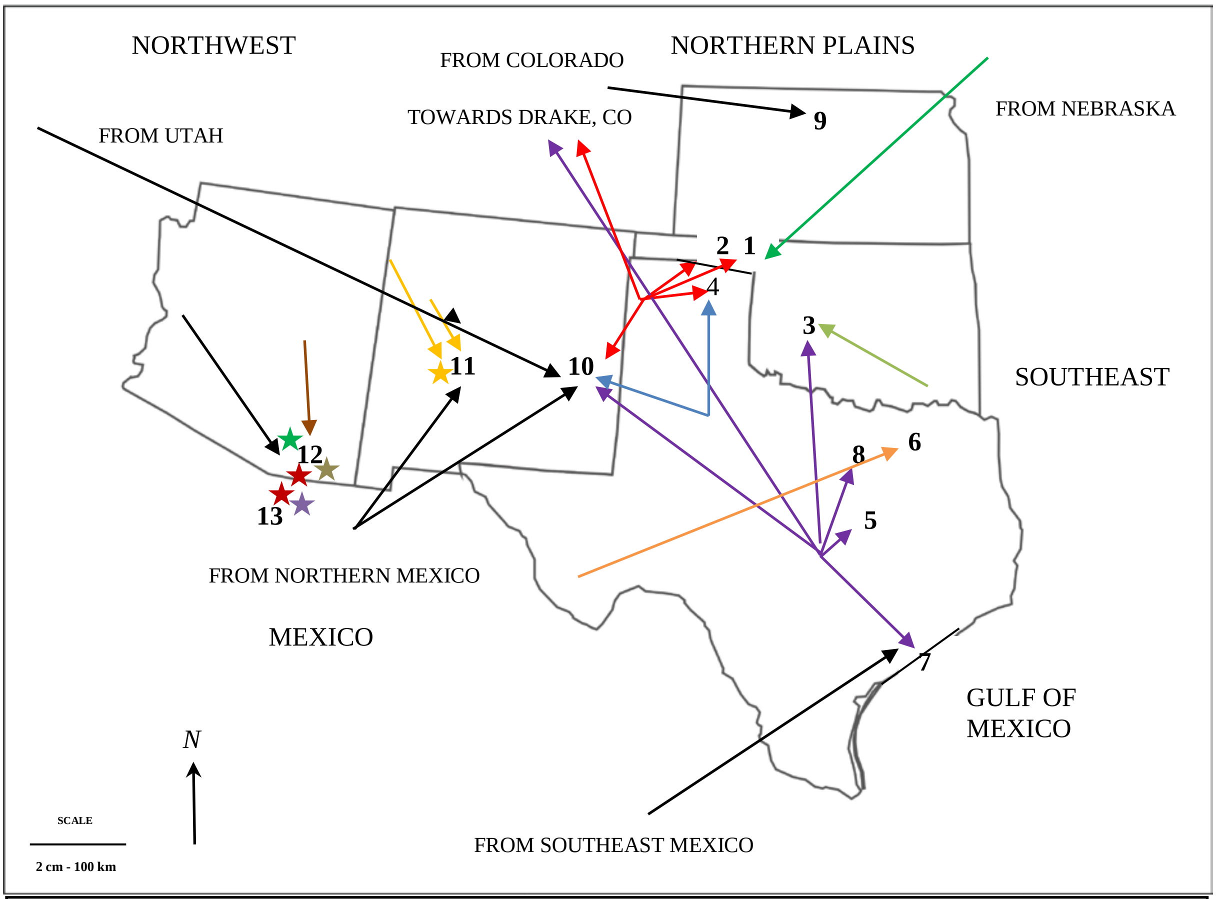
The Fenn cache, discovered somewhere on the Utah, Wyoming, and Idaho border in the early 1900s (Frison and Bradley 1999), had several Clovis produced on a smokey quartz crystal from an unknown source, most likely Pikes Peak region of central Colorado. Other materials present were obsidian which has been sourced to southeastern Idaho, Green River chert from southwest Wyoming, and the Amsden chert that was present in other Clovis caches in the region (Table. 2.1).

The Dent site was the only excavated site in the region prior to 1975 (Figgins (1933), and prior to the mid 1980s the only record of Clovis lithic artefacts consisted of reports of surface-collected finds of fluted points (Holen 2001). This reinforces the importance of isolates and surface-collected points, and supports their inclusion in my sample analysis. I have at least fifteen Clovis points from twelve sites in Colorado, Wyoming, Nebraska, and North Dakota from isolate occurrences in my complete sample (Tables. 3.2; 5.1)

In Wyoming the Colby site has four Clovis points made on local raw material that was sourced in the Bighorn Mountains in northeast Wyoming. One point, spec # C3411 (CBY 02), was made on a banded variety of chert from the Madison Formation, two others, C3408, and 38107 (CBY 01, CBY 04), from a red phosphoria chert, and the fourth, 38105 (CBY 04), from a dull blue phosphoria chert from the Amsden Formation (Frison and Todd 1986).

Clovis points from the Casper site in Wyoming, Amick cache, Montana, Fenn cache on the Utah, Wyoming, and Idaho border, and the Simon cache from Idaho, are also made from the Amsden chert.

In South Dakota there is one represented in my analysis: the Lange-Fergusson site from the White River Badlands, which is currently the oldest accepted and reliably dated Clovis site in North America at 11,080 ± 40 ^{14}C BP / ~13,000 Cal yr BP (Table. 2.2). It is a mammoth kill and has two complete Clovis points present in the assemblage (Table. 4.2). The raw material that these points were made from is a black opaque chert and light brown chert, both from the Minnelusa Formation in the Black Hills Uplift, southwest South Dakota about 150 km away (Hannus 1990).



SITES

1 Jake Bluff, OK
2 Bull Creek, OK
3 Domebo, OK
4 Miami, TX
5 Gault, TX
6 North Sulphur River, TX
7 McFaddin Beach, TX
8 Lewisville, TX
9 Eckles, KS
10 Blackwater Draw, NM
11 Mockingbird Gap, NM
12 San Pedro Valley Sites, AZ (Lehner, Naco, Murray Springs etc)
13 El Fin Del Mundo, MEX

RAW MATERIAL

* Alibates chert
* Edwards chert
* Lynn Mountain quartzite
* Tecovas jasper and quartzite
* Butterscotch chert
* Zacualtipan obsidian
* Jemez obsidian
* Chuska and China cherts, and Socorro jasper
* St. David chalcedony
* Carr Canyon quartz crystal
* Unnamed pinkish grey, grey, reddish brown cherts, dark grey felsite, and translucent chalcedony,
* Cow Canyon obsidian
* Mogollon Rim petrified wood
* Clear quartz crystal
* Dakota formation quartzite

[1] *All the sites on the map are included in the main raw material breakdown: Table. 4.2*
[2] *Only the main toolstone types from Table. 4.2 are included in the regional map: Figure. 4.5*

Stars indicate raw material sources from within the general area of the site, arrows indicate general distance of the source

Figure. 4.5 Map of the Clovis-aged sites from the Southern Plains and Desert Southwest region discussed above, and the main toolstone types and their sources that are present in the assemblage. See also Table. 4.2

4.2.5 Region 5: Southern Plains and Desert Southwest

The Southern Plains and Desert Southwest region is split into two subregions, (see Chapter 2). The first subregion to be reviewed here is the Southern Plains, which includes the states of Kansas, Oklahoma and Texas. Some scholars break-down the Northern and Southern Plains regions and treat the states of Nebraska (northern plains) and Kansas (southern plains), and the eastern half of Colorado (northern plains) as a separate area, and it is sometimes termed the Great Plains in the literature (see Holen 2014:178).

Southern Plains subregion

As I mentioned above, the central Great Plains area is well-suited to address lithic procurement and mobility patterns. Regional studies for Clovis adaptations are available (*e.g.* Johnson 1991; Holen 2014). Southern Plains Clovis archaeological sites in the central Great Plains are rare, but a surface-collected assemblage of Clovis lithics from the Eckles site in north-central Kansas makes a significant contribution to understanding Clovis lithic procurement in not just Kansas, but the whole region (Holen 2010). The Clovis lithic assemblage from the Eckles site is significant because it offers new data on Clovis mobility and long distance lithic movement (Holen 2010; Boulanger *et al.* 2015). The raw material that the points were made on is Flattop Butte chert from northeastern Colorado (Hoard *et al.* 1992).

An interesting observation on the morphology of the Clovis fluted points from Eckles is that there are clearly two different shape forms, but made on the same toolstone, presumably at the same time due to the circumstances of the discovery. Two of the points resemble other Clovis point forms from the Northern and Southern Plains regions, whilst the larger thinner form is more reminiscent of the forms from the east.

The Edwards chert present in the Domebo assemblage comes from around 400 km to the south in central Texas, it is uncertain where the quartzite comes from, but there are outcrops of a very similar material from the Lynn Mountain Formation, in the Ouachita Mountains in southeast Oklahoma, about 300 km away (Hart 1963). The use of the high quality Edwards Plateau chert toolstone is also reported from a cache in southwestern Oklahoma, at Andarko, also in Caddo County (Hammatt 1970). The movement of toolstone of this type over 400 km from the central Texas source supports a hunting and caching model whereby caching lithic raw material was a means of making sure that there were stores of good quality toolstone available for later visits (*e.g.* Collins *et al.* 2007; Kilby 2008).

Another important lithic raw material utilized by the Clovis groups in this region was Texas Alibates chert, which has its primary outcrop area in the Texas panhandle (Bement 2014). This material has been found in lithic assemblages from Clovis mammoth and bison kill sites at Blackwater Draw, New Mexico; Miami, Texas; and Jake Bluff, Oklahoma.

It has been suggested that some of the Clovis fluted points and other lithics from the McFaddin Beach surface sites, on the Texas Gulf coast, were made from Knife River Flint (Banks 1999; but see Speer 2014b). If this were the case, then the toolstone would have travelled over 2400 km from sources in North Dakota. Most of the lithic raw material was identified by L. Banks (Banks 1999), and his conclusions have since gone under scrutiny, as several problems regarding the identifications exist (Patterson 2000). Many of the observations were made by eye and this process raises concerns over identifying raw materials in such a way. Lithic materials from different sources can have similar characteristics and appearance. It is most likely that a variety of Edwards Plateau chert, similar to the Knife River chert, was used to produce the majority of the lithic assemblage; the closest source of Edwards chert is over 450 km (Table 4.1). However, there was a fragment of a Clovis point found that was not in the Bank's study, made from Zacualtipan obsidian, from Hidalgo in southeast Mexico, which is up to 1500 km away, so long-distance transport of toolstone did occur within the Clovis groups that were in the McFaddin Beach area. The obsidian was analysed and sourced using the X-ray fluorescence method (Hester *et al.* 1992; Giauque *et al.* 1993). So there was some evidence for extreme long distance movement of toolstone at McFaddin Beach.

By far the most common toolstone found in Clovis point occurrences in Texas are the Edwards Plateau and Texas Alibates cherts; there are numerous caches, isolates, and surface-collected points. These occurrences were sourced from the Texas Fluted Point Survey and its revisions through my literature review (Meltzer 1986a, 1986b; Meltzer and Bever 1995; Bever and Meltzer 2007), and the Paleoindian Database of the Americas (PIDBA) and its updates (Anderson 1990a; Anderson *et al.* 2010; Anderson and Miller 2017). Some of the more important and well-known caches and isolates are recorded in supporting information (Appendix. A.). There are however some interesting toolstone varieties that appear in the isolate and surface-collected assemblages that I included in my comparative sample (Table. 3.2).

The remainder of what is known about Clovis elsewhere in this subregion is made up of other isolates and surface-collected Clovis fluted points and other lithics (*e.g.* Meltzer 1984; Brown and Logan 1987; Myers 1987; Blackmar 2001; Hoffman and Hesse 2003; Holen 2003). Some of these isolates and surface-collected points made up my comparative sample, and were included in my analysis (Tables. 3.2; 5.1), and other Clovis sites are listed in the appendices (Appendix. A).

Desert Southwest subregion

The subregion covered in this study includes the states of Arizona and New Mexico and parts of northwestern Mexico, and includes many well-documented Clovis sites that contain

Clovis fluted points and appear in my main analysis (*e.g.* Haury 1953; Haynes 1955; Haury *et al.* 1959; Hemmings and Haynes 1969; Hester 1972; Haynes and Huckell 2007; Sánchez *et al.* 2014), and numerous isolated finds recovered throughout the region, some of which make up my comparative sample (Tables. 3.2; 5.1). In New Mexico, surface exposures of high quality lithic toolstone were mainly available along the northern and easterly margins of the escarpments of the Llano Estacado. Edwards Plateau chert, Texas Alibates agate, and Tecovas jasper were by far the most common materials utilised by the Clovis groups for the manufacture of their stone implements in this region (Green and Kelley 1960; Shelly 1984; Hamilton *et al.* 2013), and in particular the fluted points (Boldurian and Cotter 1999:23).

In eastern New Mexico, the Clovis type site at Blackwater Draw Locality No. 1, Roosevelt County, has Clovis fluted points in the assemblage made on all three of the materials above (Warnica 1966; Hester 1972; Boldurian and Cotter 1999). The most common lithic raw material that Clovis points were produced from in the assemblage was Edwards chert, then Alibates chert. Although Tecovas jasper has excellent fracture qualities, it appears to have been the 'third choice' toolstone of the early Paleoindians in this subregion, a fact possibly down to restricted distribution (Holliday and Welty 1981). These materials are all available from outcrops less than 500 km away to the northeast and southeast in Texas (Table. 4.1). The remainder of the lithic assemblage and a few Clovis points are made of material that resembles quartzite from the alluvial deposits from the Dakota Formation outcrops near Fort Summer, that are less than 100 km to the west, and Tucumcari less than 150 km to the north, and an obsidian variety from the Jemez Mountains in northern-central New Mexico, 350 km to the northwest (Johnson *et al.* 1985). There is one other noteworthy Clovis fluted point in the assemblage that represents an extreme long-distance transport of toolstone (Table. 4.1). The point is made on a variety of obsidian that has been sourced to Wild Horse Canyon, in southwestern Utah, some 950 km away (Nelson and Holmes 1979;

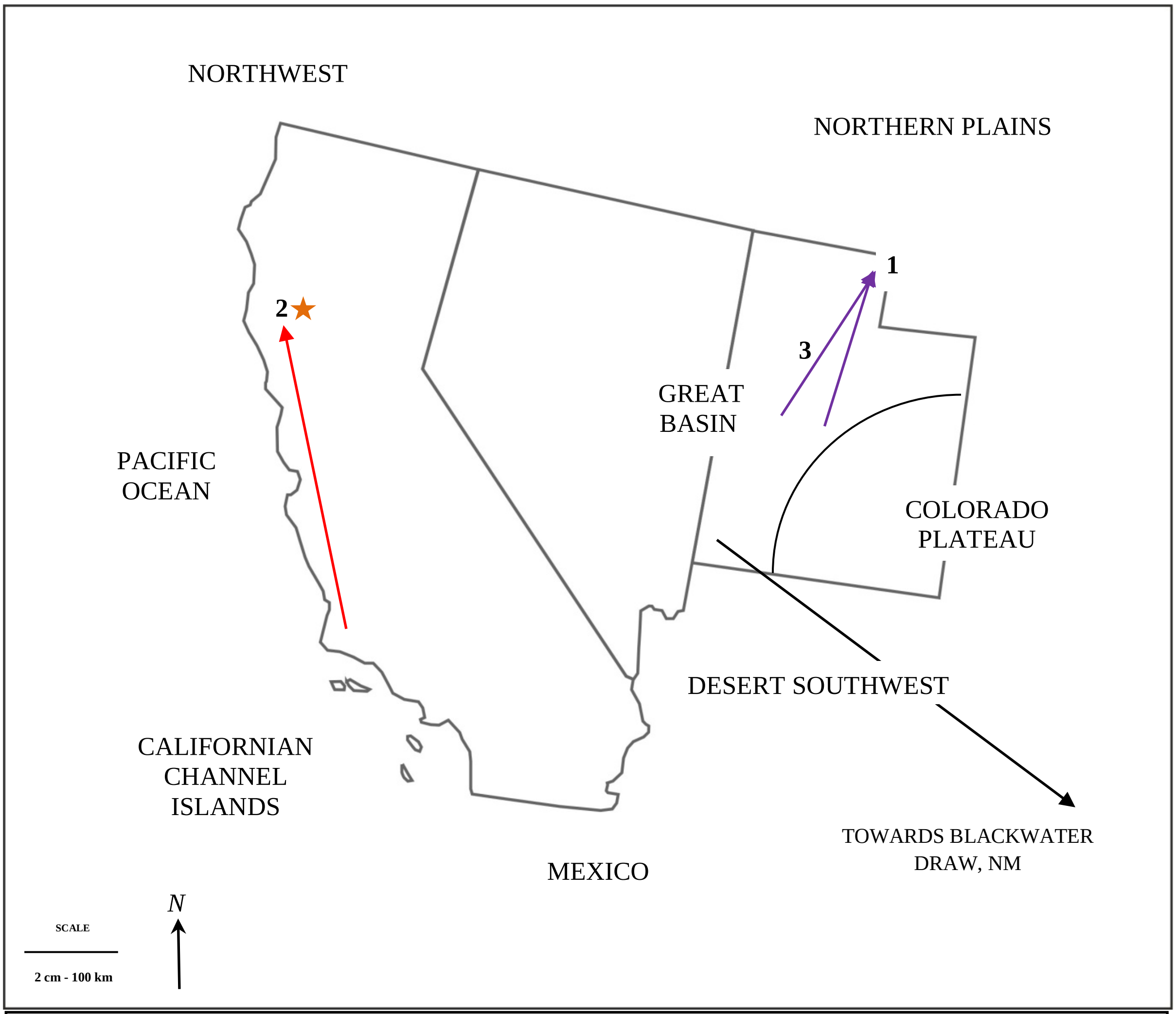
Nelson 1984). This represents the second-longest distance movement of an obsidian Clovis artefact recorded in North America (Holen 2004), and I was able to include this point in my main sample (Table. 3.1). The furthest example of obsidian movement is a broken Clovis point from the Kincaid Rockshelter in Texas (Appendix. A). The obsidian was sourced to Queretaro in central Mexico, some 1000 km from the site (Collins *et al.* 1989; Collins 1999a).

The most dominant toolstone in the Mockingbird Gap, New Mexico, assemblage is a greenish black unnamed chert, that has an unknown source, but is believed to be relatively local (Weber and Agogino 1997). Edwards Plateau chert, and the Texas Alibates chert are surprisingly absent from the assemblage, and suggests that the Clovis group occupying the campsite previously foraged elsewhere, and came from the northeastern region of New Mexico.

It was noted that neither of the more well-known lithic materials of Texas Alibates or Edwards Plateau chert were utilised by the San Pedro Valley Clovis groups (Hemmings 1970: 173; Huckell 2007), and the attempts to get exact identification of specific sources on some of the toolstone proved difficult. The mountains that border the valley contain abundant exposures of the sedimentary rocks that contain large nodules of the cherts that were present in the Lehner, Naco, Murray Springs and other Clovis point assemblages (see Gilluly *et al.* 1954; Hayes and Landis 1965; Bryant 1968). The exposures are abundant through the Huachuca and Whetstone Mountains on the western side of the valley, and in the Tombstone Hills, Mule Mountains, and Naco Hills to the east, all within 100 km of the Clovis sites in the valley (Figure. 4.5; Tables. 4.1, 4.2).

A surface-collected Clovis fluted point from Cerro Guaymas, Sonora in Mexico, is also included in my comparative sample (Table. 3.2). It was discovered in 1954 (Di Peso 1955), and is made from an unnamed dense black obsidian. The point's characteristics were said to closely resemble the San Pedro Valley Clovis points in aspects of manufacture, design, fluting and edge grinding. Obsidian sources in northern Sonora are well-known but are poorly- reported (Shackley 2005b); it is most probable that the obsidian variety used to produce the Cerro Guaymas point came from one of the sources from northeastern Sonora, Mexico (Shackley 2005a, 2005b).

Clovis fluted points from the southwestern United States tended to be produced from high quality cryptocrystalline toolstone obtained from distant sources, whereas in northern Mexico, there seems to be a greater reliance on locally-available basalts, rhyolites, and quartz. More research needs to be done to determine whether this represents decreased mobility on the part of early Paleoindian groups, or whether it is due to raw material restraints in a area of the region dominated by volcanic geology, or perhaps both (Gaines and Sánchez 2009).



SITES [1]

1 Fenn [3] UT, WY, ID border
2 Borax Lake, CA
3 Dugway Military Proving Ground, UT

RAW MATERIAL [2]

* Utah agate
* Wild Horse Canyon obsidian
* Borax Lake obsidian
* Franciscan chert

[1] *All the sites on the map are included in the main raw material breakdown: Table. 4.2*
[2] *Only the main toolstone types from Table. 4.2 are included in the regional map: Figure. 4.6*
[1] *Included Fenn as there is uncertainty of the exact location, but is believed to be somewhere along the Utah / Wyoming / Idaho border*

Stars indicate raw material sources from within the general area of the site, arrows indicate general distance of the source

Figure. 4.6 Map of the Clovis-aged sites from the Southwest and Great Basin region discussed above, and the main toolstone types and their sources that are present in the assemblage . See also Table. 4.2

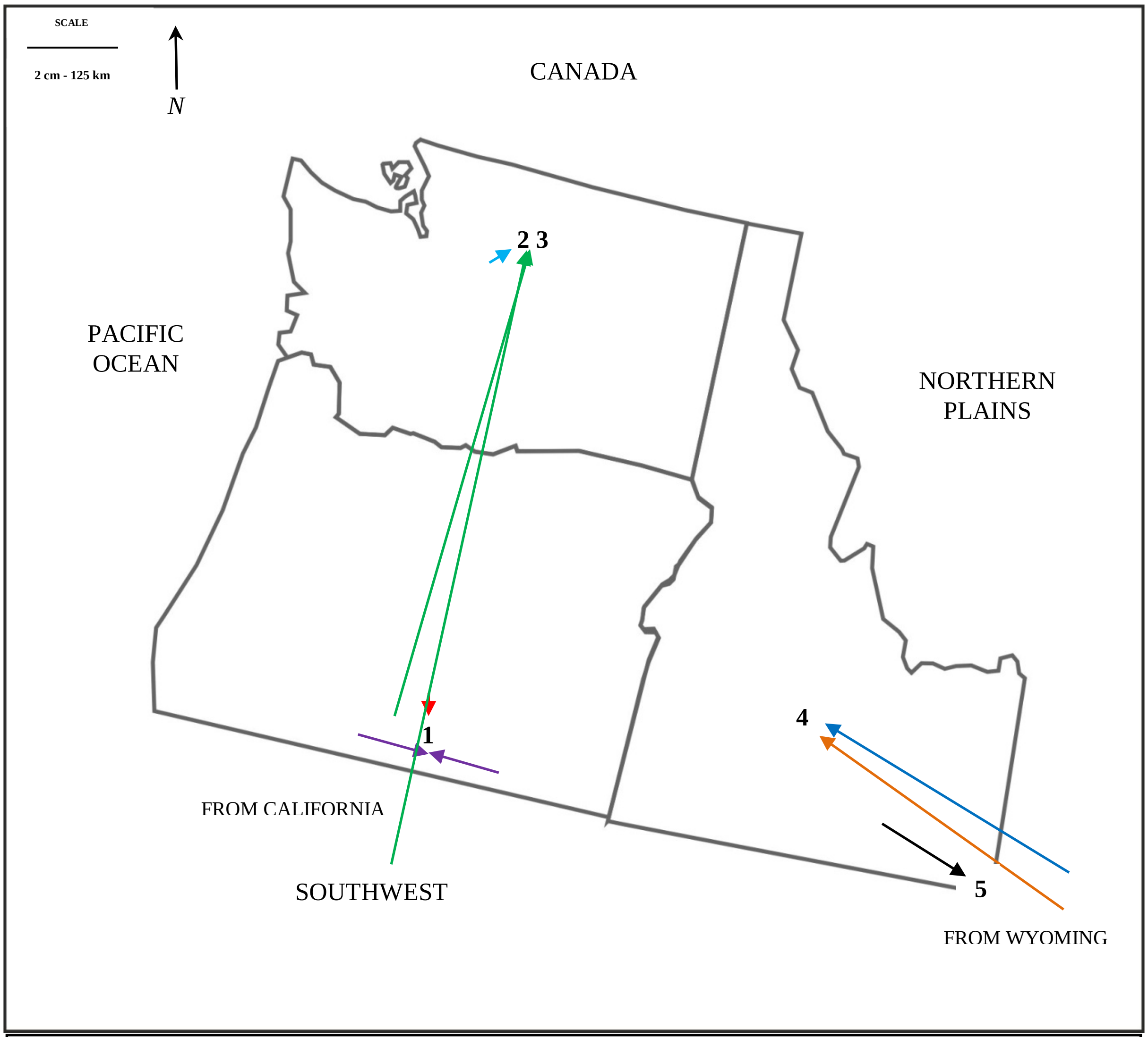
4.2.6 Region 6: Southwest and Great Basin

This region includes the parts of the Great Basin, Colorado Plateau, and California as laid out in Chapter 2. The Clovis archaeological record for this area of the region is almost entirely made up of surface-collected finds (Beck and Jones 1997), and several of these appear in my comparative analysis and supporting analysis samples (Tables. 3.2; 3.3; 5.1). A number of isolated surface-collected Clovis fluted points have been reported from Nevada (see Perkins 1967; Davis and Shutler 1969; Tuohy 1985; Taylor 2003), but unfortunately none appear in any of my analyses. Most of the lithic raw material that the points were made on are relatively local cherts, volcanic tuff and varieties of obsidian (Davis and Shutler 1969:157; Taylor 2003). At the Lime Ridge Clovis campsite, San Juan County, one of a only a few Clovis archaeological sites in Utah (Davis and Brown 1986; Copeland and Fike 1988), it is interesting to note that Clovis groups chose to ignore abundant local sources of quartzite that later Paleoindian and Archaic groups utilised, and preferred petrified wood, quartzite, and jasper (Davis 1989). This site and other Clovis-aged assemblages are discussed further in the appendices (Appendix. A)

Similarly to Nevada, there are not many Clovis archaeological sites in Utah, although several studies have been made (see Davis and Shutler 1969; Madsen *et al.* 1976; Copeland and Fike 1988). There are two Clovis fluted points in my sample M analysis. The first is the obsidian point that was found at the Clovis type site at Blackwater Draw Locality No. 1. in New Mexico (Holen 2004). Although found at this location, the point was almost certainly produced in Utah where the obsidian was sourced to and is therefore included in this lithic raw material overview (Nelson 1984). The source is in southwestern Utah and represents an extreme long distance movement of toolstone. The second point from Utah is another isolated obsidian point, found in Tooele County in northwest Utah, at the Dugway Proving Ground (Table. 5.1). Unfortunately at the time of my data collection, the source of the obsidian had not been identified as the Clovis point has not been sent for analysis. However, all the obsidian Clovis points recorded from Utah occur in western Utah and are relatively near obsidian source areas (Nelson and Holmes 1979), and so there is no reason to suggest that this specimen was not made from a variety of obsidian that was local.

The Colorado Plateau lies to the east and south of the Great Basin; there are very few Clovis fluted points from this area compared to those of later technologies (Copeland and Fike 1988). Very little dating of the extant specimens has been carried out, and certainly no occurrences of direct association with Clovis-age points with extinct megafaunal species exist (Haynes 2002). Of all the recorded Clovis points recorded from the Colorado Plateau, the predominant toolstone present are varieties of chert, followed by obsidian, chalcedony and quartzite (Copeland and Fike 1988).

California makes up the last area of the Southwest and Great Basin Region to be discussed, and has several Clovis fluted point assemblages that made up my samples. The China Lake valley area of eastern California contains a series of eroded archaeological localities that include Clovis-aged sites (Davis 1975, 1978) that contain Clovis fluted points, many of which are on restricted land owned by the U.S. Navy, such as the Naval Air Weapons Station (NAWS) in the Mohave Desert (*e.g.* Yohe II and Gardner 2016). I was able to get research reports from some of the Clovis fluted points (Rondeau 2003, 2005), and I have included these in my supplementary samples (Table. 3.3). The lithic raw materials used to produce the Clovis fluted points were varieties of local chert, obsidian, rhyolite and jasper. Other notable Clovis-aged sites that do not appear in my analysis are discussed in supporting evidence (Appendix. A).



SITES	**RAW MATERIAL**
1 Dietz and Hoyt, OR	* Glass Butte obsidian
2 East Wenatchee, WA	* Unnamed obsidian
3 Badger Mountain, WA	* Ephrata agate
4 Simon, ID	* Rainbow obsidian
5 Fenn [1] UT, WY, ID border	* Amsden chert
	* Green River chert
	* Malad obsidian

[1] Included Fenn as there is uncertainty of the exact location, but is believed to be somewhere along the Utah / Wyoming / Idaho border

Stars indicate raw material sources from within the general area of the site, arrows indicate general distance of the source

Figure. 4.7 Map of the Clovis-aged sites from the Northwest region discussed above, and the main toolstone types and their sources that are present in the assemblage. See also Table. 4.2

2.2.7 Region 7: Northwest

The final region to be assessed here is the Northwest, which covers the states of Idaho, Oregon and Washington. Dated Clovis sites with buried stratified deposits are rare in this region: many of the occurrences of Clovis fluted points in the Pacific Northwest are from isolated surface-collected reports (see Meltzer and Dunnell 1987; Connolly 1994; Ozbun and Stueber 2001: Croes *et al.* 2008). In Idaho the picture is much the same, where the majority of Clovis fluted point reports are isolates (see Huntley 1985; Petersen 1987; LeTourneau 2010; Pitblado and Fowler 2011; Reid *et al.* 2014). Some of these isolates are part of my main, comparative, and supplementary samples and form my analysis of Clovis fluted points in the Northwest region (Tables. 3.2, 5.1), and other Clovis point occurrences are discussed in the appendices (Appendix. A).

In Idaho the Simon site has fluted points made on varieties of chert that have been identified as coming from the Amsden Formation in northern Wyoming, over 800 km away for the phosphoria and grey cherts, and the Green River Formation in southwestern Wyoming, again 800 km away for the Green River variety of chert (Kohntopp 2010). Both of the toolstone types represent long distance transport or movement (Figure. 4.7; Table. 4.2). Identification studies of the toolstone present at the Simon site have been carried out (*e.g.* Kilby 2008; Kohntopp 2010), which suggested the sources for the toolstone lay beyond the region. Some researchers, however (*e.g.* Santarone 2014:19), pointed out that as chert toolstone sources are both extensive and poorly-documented, more local chert toolstone acquisition should not be ruled out.

The absence of obsidian at the Simon site has recently been the subject for debate (Santarone 2014:16; Reid *et al.* 2014: 56), which had become an assumption that obsidian was being ignored in Idaho by the Clovis knappers (Connor and Kunselman 1997), and a survey of Idaho of Clovis fluted points mentioned only one obsidian specimen from nine sites (Titmus and Woods 1991), with the suggestion that Clovis points in Idaho were being almost entirely produced on cherts from distant sources. This suggestion was overturned shortly afterwards when X-ray fluorescence sourcing was applied to obsidian Clovis isolates, several of which make up my various samples (Table. 5.1). Seagull Bay (10PR89), in Portola County, and Lake Cascade (10VY563), in Valley County, are two such sites that have Clovis fluted points that are made on localy- sourced obsidian (Hughes 2008; Reid *et al.* 2014), and both appear in my sample (Tables. 3.3; 5.1).

The majority of Clovis fluted points in Oregon are also represented by isolates or surface-collected finds (*e.g.* Gerity 1960; Connolly 1994; Ozbun and Steuber 2001; Taylor 2003). The Dietz and Hoyt sites in Lake County, Oregon, are possibly two Clovis campsite locations that are part of a much larger campsite. Dietz is the largest Clovis site known in the Pacific Northwest to date (see Willig 1984; Fagan 1988; Pinson 2008, 2011). The site is composed of a number artefact clusters, and over seventy-five whole and fragmentary fluted points are associated to the Clovis occupation, although there is also a Western Stemmed Tradition (WST) component present as well (Fagan 1985, 1988). The entire assemblage at the Dietz site is made on varieties of obsidian, all of which are sourced from within 120 km. A Clovis fluted point discovered in the vicinity of the Dietz site in the 1950s is made on a variety of Glass Butte obsidian sourced to 40 km away (Tables. 4.1). The Clovis fluted points from both Dietz and Hoyt also demonstrate heavy flute scratching that is present on many obsidian Clovis fluted points, which has been linked with the hafting process of Clovis fluted points to a wooden haft (see Slade in press a).

There are also some Clovis fluted point isolates from Oregon that are made on toolstone other than obsidian, and two of these make up my comparative sample (Table. 3.2), these specimens, along with other Clovis sites and assemblages from Oregon that are not directly related to my samples are discussed in the supporting information (Appendix. A).

As with other areas of this region, other Clovis fluted point occurrences and Clovis sites not directly related to any of my samples are discussed in the appendices (Appendix. A), as well as two further sections, Further North and Farther South (Appendix. A); that I do not include in this study, but which are relevant to North American Clovis distribution.

4.3 Interpretation of regional and intraregional patterns

Whilst carrying out the review of the regional distribution of Clovis sites and fluted point locations and the sources of the respective toolstone used to produce them. I was particularly concerned with the question of how did the data help to understand movement of Clovis groups? This has an impact on my research question, and is briefly outlined below, but will be discussed in more detail in Chapter 5.

In the Northeast region, the majority of the Clovis-aged sites are campsites. Of the eight sites in the region-seven are camps or kill / camp locations, the exception being Debert, from Nova Scotia which is designated as a kill site, but could also be a kill / camp (Figure. 4.1; Table. 4.2). These campsites are mostly associated with seasonal migrations of caribou and deer, and were probably seasonally revisited. In some cases an adequate toolstone is close-by, but is either ignored or was not noticed. Of the eleven most common toolstone types present in the point assemblages, only five are sourced within 50 km, and the majority are over 250 km. There is a fair amount of intrasite activity, with some raw materials being present in more than one assemblage, and although there is one example of intraregional activity with Onondaga chert travelling southeast to Williamson in Virginia [14] ; the raw materials from the

[14] In some cases the regions of the Northeast and Middle-Atlantic overlap, with some authors including Virginia in the Northeast. I decided to include Virginia in the Middle-Atlantic region

northeast are restricted to this region. This suggests to me that once Clovis entered the region and became established they stayed there. The possible evidence for this is threefold: firstly through the raw material analysis mentioned above. Second, that this behaviour may explain the high percentage of large campsites, which were being used as seasonal base camps, and thirdly, that if these Clovis groups were in fact following the caribou and deer herds around the region, the archaeological and faunal records suggest that caribou were one of the primary prey species hunted by early Paleoindians in Northeast and Great Lakes (Simons 1997; O'Shea *et al.* 2013).

In contrast to the Northeast, the Middle-Atlantic subregion has no toolstone travelling over 200 km and after removing the regionally local material from Williamson and Cactus Hill, both in Virginia, the most furthest travelled toolstone is an oolitic quartzite from South Carolina over 150 km to the south; the rest of the sites were getting toolstone from at source, very local, or local (Figure. 4.2; Table. 4.2).

Two sites from the Delmarva Peninsula were getting cherts and jaspers from up to 150 km away. The breakdown of sites from the Middle-Atlantic and Southeast region is a combination of campsite and quarry / workshops in the Middle-Atlantic, and kill / camps and a campsite and a workshop in the Southeast. But the sample of sites is poor, with only four from each subregion represented in my sample. As I was concentrating on Clovis points, it may well be that some of the raw material occurrences are instances of transportation of finished points and is not indicative necessarily of toolstone procurement or sourcing in the region (see Smallwood 2012; Parish and Finn 2016).

In the Midcontinent and Great Lakes region there are occurrences of local and very local material being present at one particular site or location only, with the exception being Flint Ridge chalcedony; however, it is only present at one site within the region, the other occurrences are outside the region (Figure. 4.3; Table. 4.2). The majority of Clovis sites in this region are kill sites and kill / camps; there is a single workshop / quarry site and a cache. The appearance of caches is interesting, although there has been a suggestion that some of the extreme long-distance raw material at the Lamb site in New York from the Northeast region represents a cached deposit (Kilby and Huckell 2014). The other notable observation made was that Clovis activity seems to be restricted to the southern half of the region, which may have something to do with environmental conditions from the Great Lakes area and fast-flowing glacial water which fuelled rivers such as the Mississippi and Missouri, restricting Clovis group movement (see Morrow 2014a).

In the Northern Plains region, patterns indicate a great deal of activity in the west-central area of the region, with both Clovis sites and the sourcing and movement of raw materials centred within Wyoming and northeastern Colorado (Figure. 4.4; Table. 4.2). There are semi-long-distance and long-distance movement of toolstone within this region, and instances of extreme long distance movement to sites outside the region, going westwards towards Idaho, east to New York and southeast to Illinois and Kansas. The site breakdown in this region is largely represented by kill sites, and kill / camps, with quarry / workshops absent. The movement of toolstone could be related to a more mobile Clovis group pattern, and the campsites related to kill sites could be temporary processing areas rather than more permanent base camps that were present in the Northeast region. Caches of complete Clovis points made on high quality toolstone are also present in the region, also both in Wyoming and Colorado.

The Southern Plains subregion has a similar site breakdown to the Northern Plains, in that the majority are kill sites, and kill / camps. Interestingly there are no reported Clovis point caches from the entire region, but there are several blade caches in Texas and in New Mexico at the Clovis type site, and preform / point blanks caches from Texas and Oklahoma (*e.g.* Collins 1999a; Collins *et. al* 2007; Bement 2014; Condon *et al*. 2014; Huckell and Kilby 2014; Kilby 2014a). The most predominant, and the best-known lithic materials in the region by far are the Texas Alibates chert from the Texas panhandle area, and the Edwards Plateau chert which is available across a 100 sq km area in central Texas. These toolstone types are present in four and five sites within the Southern Plains and Desert Southwest region respectively, and they are also present at sites in Colorado from the Northern Plains region, in the Drake cache. An interesting observation is, whilst the site breakdown and movement of the two high quality raw materials within the subregions are similar, there is only one case of a toolstone coming from a local source in the Southern Plains, whilst the rest are all from 150 km away, and most being further afield still. But the evidence from the Desert Southwest subregion suggests that the majority of the Clovis points are made on very local and local raw materials, with most coming from less than 250 km away. The exception are obsidians that come from extreme long-distance, such as the examples at Blackwater Draw, New Mexico; and McFaddin Beach, Texas (Figure. 4.5; Table. 4.2).

In the Southwest and Great Basin region there is very little in the way of stratified Clovis sites; the archaeological record is predominantly a surface lithic record (Copeland and Fike 1988; Beck and Jones 1997:221), and the published accounts for subsistence and lithic procurement are sparse. The majority of Clovis points reported are isolates or surface-collected occurrences. Many of the Clovis point occurrences that are published are unfortunately not part of my analysis, but are available in my supporting information section (Appendix. A). This, along with other underrepresented areas of North America, will form the basis of future research.

Of the material that was available for analysis, the breakdown of Clovis sites in this region are formed of campsites and an isolate surface find. However, if the Fenn cache is included, as it was discovered on the Utah border, this assemblage can be added. There is no evidence of kill sites or quarry / workshops in this region, but any Clovis or Clovis-aged groups that were present would almost certainly have carried out kill site and workshop / quarry activities and behavioural patterns similar to those elsewhere. It may be that the evidence is just not there. The toolstone is almost entirely represented by obsidian varieties from Utah and California, although there is a chert from California that was present in the Borax Lake site assemblage (BXL 01). The Borax Lake obsidian is very local and the source of the toolstone (Kaufman 1978), one of several quarry sites, suggests the material may have been the reason for the camp (Frederickson and Origer 2002). The rest of the region has the obsidian occurring at: semi-long-distance, long-distance, and extreme long-distances (Figure. 4.6; Table. 4.2). Obsidian sources can be accurately determined by trace element analysis, and x-ray fluorescence analysis (*e.g.* Nelson and Holmes 1979; Nelson 1984; Johnson *et. al* 1985).

The last region to be reviewed is the Northwest region, and like the previous region, has very little in the way of stratified Clovis sites (Figure. 4.7). There are two localities in northwest Oregon, that are most likely part of a larger single campsite location, Dietz (Willig 1984), and Hoyt (Rondeau 2009a). The Clovis points at these two sites were made on varieties of obsidian within Oregon. The Dietz specimen had trace element analysis carried out and the source of the obsidian was in the Glass Butte Mountains, 43 km to the North (Pinson 2008, 2011). The Hoyt points were made on an unnamed obsidian also from northern Oregon, and if the two sites are indeed part of the same occupation or Clovis group, it is quite possible the obsidian is the same as the Dietz point (Figure. 4.7; Table. 4.2).

The region also has two caches: again if Fenn is included, as it is on the border of Idaho, and another in Washington, the Richey-Roberts cache, now known as the East Wenatchee site. The cache includes some very large Clovis fluted points; at the time of their discovery in 1987 (Gramly 1983), they were by far the largest Clovis points to be reported. The raw material used to produce these points was a local banded and variegated Ephrata agate from the Ephrata Formation, less than 50 km away to the west. Just 10 km from the East Wenatchee site, a Clovis isolate was surface-collected also in 1987, on a high plateau on Badger Mountain (Gramly 1993). At 25 cm in length it is the longest Clovis ever found. The raw material is a variety of semi-translucent Rainbow obsidian. Its appearance is black, but when tilted into the light it gives off a deep sea-green effect. The closest outcrops of this material are in the Warner Mountains northeastern California, and southern Oregon, at a minimum distance of 700 km.

Overall, obsidian seems to be the toolstone that has travelled the farthest and is also well represented local to its source. The obsidians that did travel long and extreme long distances are present as finished points, which could indicate that Clovis groups were also moving long distances or groups from other regions were converging at campsites and trading in certain items, including Clovis points made on high quality non-local toolstone, such as obsidian, took place (*e.g.* Bamforth 2009).

4.4 Recognition and identification of raw material sources

Many of the toolstone types mentioned above are highly distinctive, and can be identified with considerable confidence through a simple macroscopic analysis. Colour, mottling, texture, lustre, banding patterns, translucency, and diagnostic fossil and other inclusions are all key to an accurate identification. It is however most probable that there have been misidentifications of some of the lithic material in this study, given that not all researchers were familiar with all lithic raw materials in any particular region, let alone North America on the whole. Several studies in addressing the problems of lithic identification and the implications have been published on certain areas within regions (see Goodyear 1979; Koldehoff 1983; Morrow 1994; Morrow 2014a; Speer 2014b; Parish 2016).

Some lithic raw materials have had the terminology altered over the years in the literature that also made identification and comparisons difficult. Toolstone such as Flint Ridge chert, was sometimes called Ohio Flint Ridge chert or Flint Ridge chalcedony (*e.g.* Tankersley and Holland 1994; Eren and Redmond 2011; Boulanger *et al.* 2015). The use of visual identification to assign sources and provenance to lithic assemblages made from certain cherts is common practice, despite occasional errors in identification (see Calegoro 1992; Ferguson and Warren 1992), but there have been positive studies where visual analysis has been employed (see Spielbauer 1984; Perry 1992; Hess 1996). There has also been confusion over visual identification of Dover chert and Fort Payne chert (Parish and Durham 2015), where the two chert types have been mistakenly identified for each other due to similar characteristics in both materials occur, such as colour, lustre, mineral inclusions, and texture. A logistic regression analysis on samples has demonstrated success in differentiating chert types, but the Dover / Fort Payne case study provides a cautionary example that highlights the issues in sourcing studies that rely solely on visual identification of lithic raw materials (Parish and Durham 2015).

Some toolstone sources are geographically extensive, such as Burlington chert, Edwards chert, Texas Alibates chert, and have outcrops that stretch for hundreds of kilometres. Other toolstone types are more spatially discrete, and are more easily recognised in lithic assemblages. Toolstone such as Hixton silicified sandstone, whose provenance is a single hill in Jackson County, Wisconsin, the Tallahatta agate from southwestern Alabama, the Butterscotch chert from the Sulphur River in Texas, and Attica chert from west-central Indiana, have all been identified as the toolstone type for a particular Clovis point assemblage, or individual isolates.

One particular implication arises from identifying the distance of Edwards Plateau chert from source to findspot. The chert occurs at the northern and southern extremes of the plateau; potentially meaning a difference of 350 km (Speer 2014b), this could be significant when considering differences to local versus non-local toolstone acquisition and movement (Table. 4.2). Geochemical sourcing, or Laser Ablation-Inductivity Coupled Plasma-Mass Spectrometry (LA-ICP-MS) analysis of the lithic material can provide a more precise and accurate identification over just visual identification, and provides a better alternative than just macroscopic analysis alone (Speakman and Neff 2005). In the case of Edwards Plateau chert, four source areas of the Edwards Plateau have been identified: the Callahan Divide, Gault / Fort Hood, Leon Creek, and Wolf Creek (Speer 2014b:2). Interestingly, when it was suggested that Knife River Flint was the toolstone type that some of the Clovis points from the McFaddin Beach site in Texas were made from (Banks 1999), comparisons to a variety of Edwards Plateau chert were also offered (Speer 2014b).

Several studies have been carried out recently using trace element analysis to help verify toolstone sources of Clovis points (*e.g.* Hoard *et al.* 1992; Burke 2006; Huckell *et al.* 2011); further studies using quantitative evidence from trace element analysis are required to confirm some of the sources made solely through visual inspection (see Boulanger *et al.* 2015). The Neutron Activation Analysis (NAA) on curated lithic material helped identify the toolstone used by the Clovis group at the Paleo Crossing site, in northeast Ohio (Boulanger *et al.* 2015). Long distance movement of toolstone was confirmed at the Paleo Crossing site through successful identification of the Wyandotte chert source; furthermore, long-distance stone acquisition by either direct or indirect acquisition can now be considered, if not wholly validated in regions across North America (see Goodyear 1989; Bamforth 2009; Ellis 2011; Sholts *et al.* 2012; Speth *et al.* 2013; Pearce and Moutsiou 2014).

4.5 Summary: questions and early conclusions

For the lithic raw material overview I was primarily concerned with the toolstone that the Clovis points in my analysis were made on. Some of the toolstone types that are present in the individual site reports do not therefore show up in my study (Table. 5.1). Some non-point Clovis assemblages and blade and preform caches are discussed in supporting information (Appendix. A).

From the raw material overview, the regional breakdown of Clovis sites, and the basal variability of the points therein, two questions arise:-

- what does this tell us about Clovis movement patterns?
- how does this impact on my research question?

From my observations of the lithic raw material present in the Clovis point assemblages, a brief overview of each region can be presented:-

Northeast:

- almost all the sites in the region are campsites or kill / camp sites
- half the sites have toolstone coming from non-local sources
- strong focus on regional movement
- seasonal re-occupation evidence in some sites

Middle-Atlantic and Southeast:

- mix of campsites, quarries in Middle-Atlantic and campsites, workshops in Southeast
- local toolstone exploitation
- very small sample of assemblages

Midcontinent and Great Lakes:

- mostly kill / camp sites
- very local toolstone use in southeast of region
- west has more long distance movement of toolstone
- limit movement and site locales due to Great Lakes
- local use of Knife River chert as well as being exported

Northern Plains:

- kill or kill /campsites, but also caches of points are present
- long distance transport and import of toolstone
- limited site representation in eastern part of region

Southern Plains and Desert Southwest:

- mostly kill / camps
- blade and preform caches present
- widespread intra-regional dispersal, and movement on non-local scale and outside region
- Southern Plains subregion displays different pattern to Desert Southwest - much more local

Southwest and Great Basin:

- mostly campsites
- surface-collected finds
- clear long distance movement of toolstone and groups
- obsidian dominant toolstone
- poor assemblage sample, replicated in the archaeological record

Northwest:

- campsites and cache
- emphasis on long and local transport of obsidian
- poor assemblage sample, similarly replicated in archaeological record as previous region

From the observations I made on the lithic material movement and sourcing laid out in the regional analysis above, several of my expectations were confirmed, as well as there being some surprising results. Just how these observations impact on the basal concavity of the points will be carried forward in Chapter 5. Their relevance to my research questions will be discussed in my concluding Chapter 6.

Chapter 5

Analysis: procedures and results

5.1 Introduction

As previously discussed in Chapter 2 the existence of regional variation in Clovis has been the subject for debate since at least the 1950s. As noted, there were two main hypotheses put forward: the continent-wide adaptation, which holds that Clovis does not vary regionally (*e.g.* Haynes 1964), and the regional environmental adaptation, which suggests there is regional variation as Clovis groups were adapting their toolkits to local conditions (*e.g.* Witthoft 1952, 1954). The two hypotheses were recently revisited in an attempt to resolve the debate using a series of shape analysis methods on a sample of well-documented Clovis points (Buchanan *et al.* 2017).

To recap: my study was carried out on a greater and wider geographical sample than previous studies (*e.g.* Buchanan and Collard 2010; Buchanan *et al.* 2012a; Sholts *et al.* 2012, 2017; Gingerich *et al.* 2014; Buchanan *et al.* 2015; O'Brien *et al.* 2015; Werner *et al.* 2017, but see Smith *et al.* 2010; Morrow 2014b), and incorporated the same well-documented point assemblages that are probably the most recognisable Clovis point sites in North America (see Buchanan and Collard 2007; Buchanan and Hamilton 2009; Sholts *et al.* 2012; Miller *et al.* 2013; Buchanan *et al.* 2014). I increased my sample size by incorporating isolate, surface-collected finds of Clovis points from across North America as a comparative test: sample 2) / C, and from other well-documented and stratified Clovis sites which were available from the published literature but unfortunately were not available for direct analysis: sample 3) / S. The large amount of isolated, surface-collected Clovis points that have been recorded from across North America (Anderson and Faught 2000) were omitted from all the previous studies. However, I decided to include the isolates in my dataset.

In this chapter I will present the findings from my analysis of the basal concavity of Clovis point assemblages across North America, and combine these interpretations with those gathered from my regional overview of Clovis and the lithic raw materials used to produce these points. Where possible, I carried out a three-way analysis on the assemblages as follows:-

- a caliper-based measurement analysis carried out on all points from every assemblage (Tables. 5.1, 5.2)
- a geometric morphometric shape analysis involving principal component analysis (PCA) on points from assemblages from sample 1) / M (Table. 5.1)
- a multivariate analysis of variance (MANOVA) tests on assemblages that went through the PCA

The details of the methods and rationale for their use have been presented in Chapter 3.

NORTHEAST REGION				
COLLECTION: SITE / FINDSPOT [1]	**MY SAMPLES [2] *n* =**	**CAST, ORIGINAL, OR BOTH. LOCATION OF SAMPLE [3]**	**SITE TYPE**	**POINT CLASSIFICATION [4]**
Vail, ME	22 Sample 1) PCA 22	Cast - Smithsonian	Kill / Camp	deep-based Clovis
Bull Brook, MA	18 Sample 1) PCA 18	Cast - Smithsonian	Camp	deep-based Clovis
Sugarloaf, MA	02 Sample 3) ~	Cast - A.M. Slade Cast Coll.	Camp	deep-based Clovis
Plenge, NJ	09 Sample 1) PCA 09	Cast - Smithsonian	Camp	deep-based Clovis
Lamb, NY	07 Sample 1) PCA 07	Cast - Smithsonian	Camp / Cache?	deep-based Clovis
Shawnee-Minisink, PA	02 Sample 1) ~	Both - Smithsonian	Camp	Clovis fluted
Shoop, PA	10 Sample 1) PCA 10	Both - Smithsonian	Kill / Camp	deep-based Clovis
Upper Cross Creek, PA	01 Sample 3) ~	Cast - Smithsonian	Isolate	Clovis fluted
Debert, CANADA	05 Sample 1) PCA 05	Cast - Smithsonian	Kill / Camp	deep-based Clovis
TOTAL **Main** **Supplementary**	**75 PCA 71** **73** **02**			
MIDDLE-ATLANTIC AND SOUTHEAST REGION				
COLLECTION: SITE / FINDSPOT	**MY SAMPLE *n* =**	**CAST, ORIGINAL, OR BOTH LOCATION OF SAMPLE**	**SITE TYPE**	**POINT CLASSIFICATION**
MIDDLE-ATLANTIC SUBREGION				
Camp Pecomoth, MD	01 Sample 1) ~	Both - Smithsonian	Isolate	waisted Clovis
Jefferson Island, MD	01 Sample 2)	Both - Smithsonian	Isolate	unfluted Clovis
Lower Hooper Island, MD	01 Sample 2)	Both - Smithsonian	Isolate	Clovis fluted
Meekins Neck, MD	03 Sample 2)	Both - Smithsonian	Isolate / Camp	Clovis fluted
Buffalo Junction, VA	01 Sample 2)	Cast - Smithsonian	Isolate	Clovis fluted
Cactus Hill, VA	02 Sample 1) ~	Cast - Smithsonian	Camp	Clovis fluted
Williamson, VA	~ Sample 3)	Both - Smithsonian	Quarry / Camp	Clovis fluted
SOUTHEAST SUBREGION				
Belgreen, AL	01 Sample 2)	Cast - Smithsonian	Isolate	St. Louis Clovis
Brooklyn, AR	01 Sample 2)	Cast - Smithsonian	Isolate	Ross County Clovis
Willie, AR	01 Sample 2)	Cast - Smithsonian	Isolate	Ross County Clovis
Sloth Hole, FL	02 Sample 1) ~	Cast - Smithsonian	Kill / Camp	waisted Clovis
Adams, KY	02 Sample 3)	Original - Private Collection	Quarry / Camp	Clovis fluted
Big Bone Lick, KY	~ Sample 3)	Original - Publication	Kill / Camp	Clovis fluted
Bone Lick, KY	01 Sample 2)	Cast - Smithsonian	Surface	Clovis fluted
Boone County, KY	02 Sample 2)	Cast - Smithsonian	Isolate	Clovis fluted
Cumberland River, KY	01 Sample 2)	Cast - Smithsonian	Isolate	Ross County Clovis
Fulton, KY	01 Sample 2)	Cast - Smithsonian	Isolate	St. Louis Clovis
Riders Mill, KY	01 Sample 2)	Cast - Smithsonian	Isolate	Clovis fluted
Barton Creek, NC	01 Sample 2)	Cast - Smithsonian	Isolate / Surface	Clovis fluted
Cape Fear River, NC	01 Sample 2)	Cast - Smithsonian	Isolate	Clovis fluted
Oxford, NC	01 Sample 2)	Cast - Smithsonian	Isolate / Surface	Clovis fluted
Carson-Conn-Short, TN	02 Sample 1)) ~	Cast - Smithsonian	Camp / Workshop	Clovis and waisted Clovis
TOTAL **Main** **Comparative** **Supplementary**	**27 PCA 0** **07** **18** **02**			
MIDCONTINENT AND GREAT LAKES				
Adams County, IL	01 Sample 2)	Original - Smithsonian	Isolate / Surface	Clovis fluted
Bishop Hill, IL	01 Sample 2)	Cast - Smithsonian	Isolate	Clovis fluted
Bostrom, IL	02 Sample 2)	Cast - Smithsonian	Surface / Camp	Clovis fluted
Brownstown, IL	01 Sample 2)	Cast - Smithsonian	Isolate	Clovis fluted
Buckheart Township, IL	01 Sample 2)	Cast - C.V. Haynes Coll.	Isolate / Surface	Clovis fluted
Mueller-Keck, IL	04 Sample 1) PCA 04	Cast - Smithsonian	Camp	Clovis fluted
Pike County, IL	01 Sample 2)	Cast - A.M. Slade Cast Coll.	Isolate / Surface	Clovis fluted
Randolph County, IL	01 Sample 2)	Cast - Smithsonian	Isolate / Surface	Clovis fluted
Ready / Lincoln Hills, IL	02 Sample 3)	Originals - Publication	Quarry / Camp	Clovis fluted
Silver Creek, IL	01 Sample 2)	Cast - Smithsonian	Isolate / Surface	Clovis fluted
St. Clair County, IL	02 Sample 2)	Cast - Smithsonian	Isolate / Surface	Clovis, and Ross County Clovis
Union County, IL	01 Sample 2)	Cast - Smithsonian	Isolate / Surface	Clovis fluted
Gibson County, IN	01 Sample 2)	Cast - Smithsonian	Isolate / Surface	Ross County Clovis
Jay County, IN	01 Sample 2)	Cast - Smithsonian	Isolate / Surface	St. Louis Clovis
Big Sioux River, IA	01 Sample 2)	Cast - Smithsonian	Isolate / Surface	Clovis fluted
Cedar Creek, IA	01 Sample 2)	Cast - Smithsonian	Isolate	Clovis fluted
Rathburn Lake, IA	01 Sample 2)	Cast - Smithsonian	Isolate	Clovis fluted
Rummells-Maske, IA	05 Sample 1) PCA 04	Cast - C.V. Haynes Coll.	Camp / Cache	Clovis fluted
Gainey, MI	01 Sample 2)	Cast - C.V. Haynes Coll.	Surface	Clovis (was termed Gainey)
Genesee County, MI	01 Sample 2)	Original - Smithsonian	Isolate	Clovis (was termed Gainey)
Big Eddy, MO	~ Sample 3)	Original - Publication	Camp	Clovis (was termed Gainey)
Kimmswick, MO	03 Sample 1) PCA 03	Cast - Smithsonian	Kill	Clovis fluted
Rogers Shelter, MO	01 Sample 2)	Cast - C.V. Haynes Coll.	Camp	Clovis (was termed Dalton)

Saverton, MO	01 Sample 2)	Cast - C.V. Haynes Coll.	Isolate / Surface	Clovis fluted
Nellie Heights, OH	01 Sample 2)	Cast - Smithsonian	Surface / Camp	Clovis fluted
Paleo Crossing, OH	01 Sample 1) ~	Cast - C.V. Haynes Coll.	Camp	Clovis fluted
Welling, OH	01 Sample 2)	Cast - Smithsonian	Camp	Ross County Clovis
TOTAL **Main** **Comparative** **Supplementary**	**38 PCA 11** **13** **23** **02**			
NORTHERN PLAINS				
COLLECTION: SITE / FINDSPOT	**MY SAMPLE *n* =**	**CAST, ORIGINAL, OR BOTH LOCATION OF SAMPLE**	**SITE TYPE**	**POINT CLASSIFICATION**
Claypool, CO	01 Sample 2)	Cast - A.M. Slade Coll.	Surface / Kill	Clovis fluted
Dent, CO	02 Sample 1) ~	Both - Denver Museum	Kill	Clovis fluted
Drake, CO	13 Sample 1) PCA 13	Both - Smithsonian	Cache	Clovis fluted
Dutton, CO	01 Sample 2)	Cast - Smithsonian	Kill / Camp	Clovis fluted
Fox, CO	01 Sample 2)	Cast - Smithsonian	Surface / Kill	Clovis fluted
Greeley, CO	01 Sample 2)	Cast - Smithsonian	Surface / Kill	Clovis fluted
Kersey Gravel Pit, CO	01 Sample 2)	Cast - Smithsonian	Surface / Kill	Clovis fluted
Klein, CO	02 Sample 1) ~	Cast - Smithsonian	Kill? / Surface	Clovis fluted
Lincoln County, CO	02 Sample 2)	Cast - Smithsonian	Isolate / Surface	Clovis fluted
Nelson, CO	01 Sample 2)	Cast - Smithsonian	Isolate / Kill	Clovis fluted
Turkey Farm, CO	02 Sample 2)	Cast - Smithsonian	Isolate / Kill	Clovis fluted
Wray, CO	01 Sample 2)	Cast - Smithsonian	Isolate	Clovis fluted
Anzick, MT	05 Sample 1) PCA 05	Cast - Smithsonian	Cache	Clovis, and flat-based Clovis
Beatrice, NE	01 Sample 2)	Cast - Smithsonian	Isolate	Clovis fluted
McLean County, ND	01 Sample 2)	Cast - Smithsonian	Isolate	Clovis fluted
Lange-Ferguson, SD	02 Sample 1) ~	Cast - Smithsonian	Kill	Clovis fluted
Fenn, UT/WY/ID	07 Sample 1) PCA 07	Cast - Smithsonian	Cache	Clovis, and deep-based Clovis
Carter / Kerr-McGee, WY	01 Sample 2)	Cast - C.V. Haynes Coll.	Surface / Camp	Clovis fluted
Casper, WY	01 Sample 1) ~	Cast - Smithsonian	Isolate / Surface	Clovis fluted
Colby, WY	04 Sample 1) PCA 04	Cast - Smithsonian	Kill	deep-based Clovis
Hartville, WY	01 Sample 2)	Cast - C.V. Haynes Coll.	Isolate	Clovis fluted
Hell Gap Vicinity, WY	02 Sample 1) ~	Cast - C.V. Haynes Coll.	Camp / Kill?	Clovis fluted
Laramie Park, WY	01 Sample 2)	Cast - Smithsonian	Isolate / Surface	Clovis fluted
Niobrara County, WY	01 Sample 2)	Cast - Smithsonian	Isolate / Surface	Clovis fluted
Sheaman, WY	01 Sample 1) ~	Cast - C.V. Haynes Coll.	Camp	Clovis fluted
Wheatland, WY	01 Sample 2)	Cast - C.V. Haynes Coll.	Isolate / Surface	Clovis fluted
TOTAL **Main** **Comparative**	**57 PCA 29** **39** **18**			
SOUTHERN PLAINS AND SOUTHWEST DESERT				
COLLECTION: SITE / FINDSPOT	**MY SAMPLE *n* =**	**CAST, ORIGINAL, OR BOTH LOCATION OF SAMPLE**	**SITE TYPE**	**POINT CLASSIFICATION**
SOUTHERN PLAINS SUBREGION				
Eckles, KS	02 Sample 1) ~	Cast - Smithsonian	Kill? / Camp	Clovis fluted
Elkhart, KS	01 Sample 2)	Cast - Smithsonian	Isolate / Surface	Clovis fluted
Bull Creek, OK	01 Sample 1) ~	Both - Oklahoma University	Kill / Surface	unfluted Clovis
Domebo, OK	03 Sample 1)	Both - Oklahoma University	Kill	Clovis fluted
Jake Bluff, OK	03 Sample 1) PCA 03	Both - Oklahoma University	Kill / Camp	Clovis fluted
Dalhart, TX	01 Sample 2)	Cast - C.V. Haynes Coll.	Isolate / Surface	Clovis fluted
Gault, TX	02 Sample 1) ~	Both - Gault Research Centre	Camp	Clovis fluted
Lewisville, TX	01 Sample 1) ~	Both - Smithsonian	Kill / Camp	Clovis fluted
McFaddin Beach, TX	~ Sample 3)	Original - Publication	Isolate / Surface	Clovis, and waisted Clovis
Miami, TX	03 Sample 1) PCA 03	Cast - Smithsonian	Kill	Clovis fluted
Red River, TX	01 Sample 2)	Cast - Smithsonian	Isolate / Surface	Clovis fluted
Roaring Springs, TX	01 Sample 2)	Cast - Smithsonian	Isolate / Surface	Clovis fluted
Seminole, TX	01 Sample 2)	Cast - Smithsonian	Isolate	Clovis fluted
Sulphur River, TX	01 Sample 2)	Cast - Smithsonian	Isolate / Surface	Clovis fluted
DESERT SOUTHWEST SUBREGION				
Escapule, AZ	02 Sample 1) ~	Both- Arizona State Museum	Kill	Clovis fluted
Lehner, AZ	08 Sample 1) PCA 08	Both - Arizona State Museum	Kill	Clovis fluted
Leikem, AZ	01 Sample 1) ~	Both - Arizona State Museum	Isolate / Kill	Clovis fluted
Molina, AZ	01 Sample 2)	Cast - A.M. Slade Coll.	Surface	Clovis fluted
Murray Springs, AZ	06 Sample 1) PCA 06	Both - Arizona State Museum	Kill / Camp	Clovis fluted
Naco, AZ	08 Sample 1) PCA 07	Both - Arizona State Museum	Kill	Clovis fluted
Schaldack, AZ	01 Sample 2)	Cast - C.V. Haynes Coll.	Kill / Surface	Clovis fluted
Bigbee Ranch, NM	01 Sample 1)) ~	Both - Arizona State Museum	Kill / Surface	unfluted Clovis
Blackwater Draw, NM	24 Sample 1) PCA 19	Both - Blackwater Draw Mus	Kill / Camp	Clovis fluted
Mockingbird Gap, NM	~ Sample 3)	Original - Publication	Surface / Camp	Clovis fluted
Wagon Mound, NM	01 Sample 2)	Cast - C.V. Haynes Coll.	Isolate / Surface	Clovis fluted

Cerro Guaymas, MEXICO	01 Sample 2)	Cast - C.V. Haynes Coll.	Isolate / Surface	Clovis fluted
El Fin del Mundo, MEXICO	02 Sample 1) ~	Both - Arizona State Museum	Kill	Clovis fluted
TOTAL **Main** **Comparative**	**77 PCA 46** **67** **10**			
SOUTHWEST AND GREAT BASIN REGION				
COLLECTION: SITE / FINDSPOT	**MY SAMPLE *n* =**	**CAST, ORIGINAL, OR BOTH LOCATION OF SAMPLE**	**SITE TYPE**	**POINT CLASSIFICATION**
Borax Lake, CA	04 Sample 1) PCA 04	Cast - Smithsonian	Camp	Clovis fluted
China Lake, CA	~ Sample 3)	Original - Publication	Surface / Camp	Clovis fluted
Dugway Military Ground, UT	01 Sample 2)	Cast - A.M. Slade Coll.	Surface	Clovis fluted
TOTAL **Main** **Comparative**	**05 PCA 04** **04** **01**			
NORTHWEST REGION				
COLLECTION: SITE / FINDSPOT	**MY SAMPLE *n* =**	**CAST, ORIGINAL, OR BOTH LOCATION OF SAMPLE**	**SITE TYPE**	**POINT CLASSIFICATION**
Bruneau River, ID	01 Sample 2)	Cast - Smithsonian	Isolate / Surface	Clovis fluted
Grangeville, ID	01 Sample 2)	Cast - Smithsonian	Isolate	Clovis fluted
Jerome, ID	01 Sample 2)	Cast - Smithsonian	Isolate / Surface	unfluted Clovis
Lake Cascade, ID	01 Sample 3)	Original - Publication	Isolate / Surface	Clovis fluted
Nez Perce, ID	01 Sample 2)	Original - Smithsonian	Isolate	Clovis fluted
Seagull Bay, ID	01 Sample 2)	Cast - Smithsonian	Surface / Camp	Clovis fluted
Simon, ID	04 Sample 1) PCA 04	Cast - Smithsonian	Cache	Clovis, and flat-based Clovis
Dietz, OR	01 Sample 1) ~	Cast - Smithsonian	Camp	Clovis fluted
Fern Ridge, OR	01 Sample 2)	Cast - Smithsonian	Isolate / Surface	Clovis fluted
Fort Rock Valley, OR	01 Sample 2)	Cast - Smithsonian	Isolate / Surface	Clovis fluted
Hoyt, OR	02 Sample 1) ~	Cast - C.V. Haynes Coll.	Camp	Clovis fluted
Badger Mountain, WA	01 Sample 1) ~	Cast - A.M. Slade Coll.	Surface	Clovis fluted
East Wenatchee, WA	02 Sample 1) ~	Cast - Smithsonian	Cache	Clovis fluted
TOTAL **Main** **Comparative** **Supplementary**	**18 PCA 04** **10** **07** **01**			
TOTAL SAMPLE *n* = **MAIN SAMPLE** **COMPARATIVE SAMPLE** **SUPPLEMENTARY**	**298** **213** **77** **08**			
PCA	**165**			

[1] Entries in bold refer to Clovis point assemblages that appear in the review of key Clovis sites in Chapter 2 (Table. 2.1) and the Clovis dating table (Table. 2.2); the site distribution map of the points that make up my main analysis samples in Chapter 3 (Figure. 3.1); and my raw material analysis on the key Clovis point assemblages in Chapter 4 (Table. 4.1

[2] My sample number represents the quantity of points that were available for study at the time of my data collecting and may not represent the exact quantity in the known archaeological assemblage. M = main sample includes points from all four main site types and a few well-documented isolate / surface-collected examples; C = comparative sample of isolate / surface-collected Clovis points; S = supplementary analysis on Clovis points obtained from published literature sources

[3]. Primary location of my sample that I had access to. Full details of collections are listed in my acknowledgements and appendices (Appendix. B)

[4] Clovis and Clovis variant definition based on my observations and own interpretation

Table. 5.1 Complete sample of Clovis points that were used in the analysis; main: Sample 1); comparative: Sample 2); and supplementary: Sample 3. Whether the points were originals or cast replicas, and the location of the collections

5.2 Analysis of the samples and initial results

The PCA and caliper-based analysis was carried out on Clovis-aged points from the Northeast; Middle Atlantic and Southeast; Midcontinent and Great Lakes; Northern Plains; Southern Plains and Desert Southwest; Southwest and Great Basin; and Northwest regions as laid out in previous chapters.

ASSEMBLAGE	QTY *n* =	BASAL CONCAVITY WIDTH (mm) AVG STDEV	RANGE (mm)	BASAL CONCAVITY DEPTH (mm) AVG STDEV	RANGE (mm)
NORTHEAST					
Vail, ME	22	18.4 2.48	13 - 23	8.3 2.16	5 - 14
Bull Brook, MA	18	18.6 4.06	9 - 29	5.3 1.19	2 - 7
Plenge. NJ	9	18.1 4.83	11 - 28	4.5 1.42	4 - 8
Lamb, NY	7	20.0. 2.44	18 - 24	9.5 0.53	9 - 10
Shoop, PA	10	19.7 2.21	17 - 24	4.1 1.05	2 - 6
Debert, CAN	5*	18.2 3.89	12 - 22	10.4 3.78	6 - 15
MIDCONTINENT & GREAT LAKES					
Rummells-Maske, IA	5	22.5 1.51	22 - 24	2.3 1.30	5 - 8
Kimmswick, MO	3	16.5 2.08	15 - 19	2.6 0.57	2 - 3
Mueller-Keck, IL	4	11.2 2.88	11 - 18	2.7 0.5	2 - 3
NORTHERN PLAINS					
Drake, CO	13	21.0 1.58	18 - 23	4.0 1.01	3 - 6
Anzick, MT	5	24.2 6.61	15 - 33	1.4 0.54	1 - 2
Fenn, UT/WY/ID	7	26.1 5.14	18 - 33	6.1 1.95	3 - 9
Colby, WY	4	15.7 1.25	14 - 17	6.0 1.41	5 - 8
SOUTHERN PLAINS / DESERT SOUTHWEST					
Jake Bluff, OK	3	16.3 5.03	11 - 21	4.0 1.00	3 - 5
Miami, TX	3	17.3 3.21	15 - 21	3.3 0.57	2 - 3
Lehner, AZ	8	18.3 3.66	12 -24	3.0 1.06	2 - 5
Murray Springs, AZ	6	16.8 2.13	13 - 19	3.6 1.21	3 - 5
Naco, AZ	7	16.7 2.28	14 - 20	3.5 1.13	2 - 5
Blackwater Draw, NM	19	17.1 6.05	8 -30	3.2 0.94	3 - 5
SOUTHWEST & GREAT BASIN					
Borax Lake, CA	4	18.5 2.38	16 - 21	3.7 0.95	3 - 5
NORTHWEST					
Simon, ID	4	28.0 3.65	24 - 32	3.0 0	3

* One of the Debert points (DEB 02) turned out to be not from this assemblage, and is fact from Cape Blomidon, Nova Scotia (MacDonald 1968) and has been re-recorded as CPB 01 in my data base. I chose to include it in the Debert assemblage analysis anyway.

Table. 5.2 Results from my caliper-based analysis of the Clovis points that underwent the GM / PCA tests from across the seven regions of North America. For a more comprehensive overview of all the points to undergo the caliper-based metric analysis see Appendix. C. Sheet 2

5.2.1 Region 1: Northeast

Sample: My complete sample from this region included $n = 75$ points from eight sites (Table. 5.1). All of the points in my sample from this region came from well-published, archaeological investigations, with none of the points being isolates. All of the points underwent the caliper analysis (Table. 5.2). Unfortunately, two assemblages had to be omitted from the morphometric analysis: Shawnee-Minisink in Pennsylvania, as the assemblage contained only two Clovis fluted points, and the Sugarloaf site from Massachusetts, as I only had access to two casts of points from this assemblage (Slade 2018) and the published material for this site (Gramly 2015). That left $n = 71$ from six assemblages that went through geometric morphometric (GM) analysis and then PCA (Figure. 5.1).

Visual observations and caliper tests: The basal concavity of the Vail fluted points from Maine are all visually very similar in style, and the caliper tests and morphometric analysis confirmed this. When all twenty-two were looked at, my visual observations showed no significant differences in the morphology of the basal sections, and the caliper-based metric analysis indicated the bases were similar (Table. 5.2). A literature review of the Vail site's other fluted points that were unavailable for study (see Gramly and Rutledge 1981; Gramly 1982, 1984, 2009a) also showed no significant differences in basal morphology. I recorded the Vail points as having a deep v-shaped to u-shaped concave base with both sharp and rounded basal ears. I consequently designated these points as being a deep-based Northeast Clovis, although there was at least one other variant present: a St. Louis Clovis (Table. 5.3). This classification, as well as all future classifications on future point types to be discussed below, has been modified from the terms already in use in the literature (Table. 2.3), and after my analysis I suggest my own classification based on the basal morphology (Table. 6.2).

Bull Brook, Massachusetts, also has an unknown quantity of Clovis fluted points, but over forty have been recently documented (Gramly 2015). I included eighteen of them in my original sample (Table. 5.1), which formed part of the caliper analysis (Table. 5.2). After the selection process I ended up with $n = 18$ for the morphometric analysis. The points display the deep basal concavity, a characteristic of many fluted points in the Northeast (Gramly 2015), quite similar to the bases of the Vail points, in that they have a deep u-shaped basal concavity. Several of the points have quite long narrow flutes, and are also a little larger overall than the Vail form, and have more of a triangular blade section. After I carried out my analysis I also designated these points as deep-based Northeast Clovis (Table. 5.3).

The Lamb site in New York, has at least ten fluted points documented (Gramly 1988b, 2012). I had access to seven points which were all included in my caliper and morphometric analyses (Figure. 5.1; Table. 5.2). Although the specimens display similar characteristics in basal concavity to the Vail and Bull Brook points, they differ through their overall size, raw material type and origin, and their cultural discovery: i.e. they might be evidence of caching (Gramly 1999; Ellis 2004). [15]Another observation made during my caliper analysis, was that many of the points in the assemblage demonstrate very similar fluting and other technological similarities. My caliper-based analysis revealed that the seven points had a basal concavity depth of 9 -11 mm; the other three points I did not have direct access to also had a depth of between 9 and 11 mm (Gramly 1999:65). I assigned these points to the deep-based Northeast Clovis type (Table. 5.3).

At Plenge, Pennsylvania, there are an unknown number of Clovis points amongst the other Early Paleoindian, Middle Paleoindian, and Late Paleoindian assemblages present (Gingerich 2013b). The earliest points at the Plenge site have been considered to be of

[15] Ten Clovis fluted points from Cluster C area at the Lamb site, are said to be part of a cache, all of the points are made from non-local lithic raw material, that would represent the only Clovis in the Northeast region (Gramly 1999)

Clovis-age (Gingerich 2013b:125), but judged just on metrics and technology, few fit the general view of Clovis (*e.g.* Bradley *et al.* 2008). The Plenge assemblage of $n = 9$ points that I used in my analysis is a small sample of small Clovis fluted points that display a shallower u-based basal concavity, and are more similar to the Shoop points than those from Vail or Debert. Overall, after the caliper and morphometric analyses, I still designated the Plenge points as a deep-based Northeast Clovis.

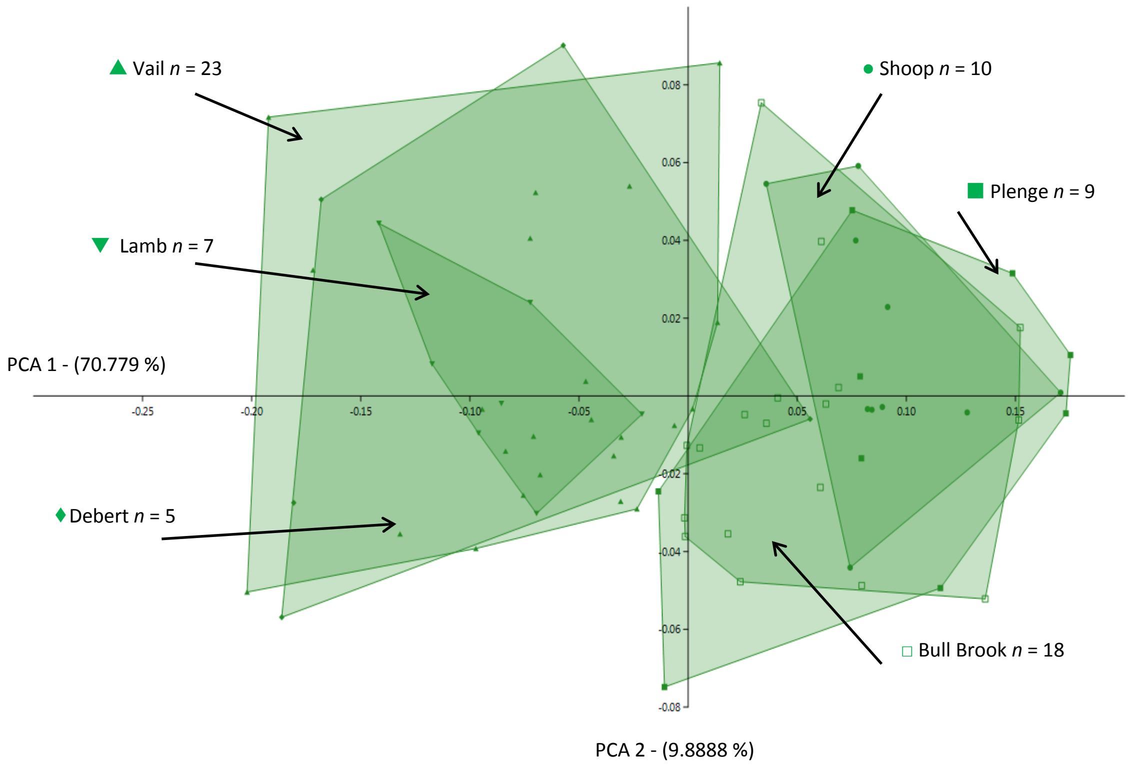
The Shoop sample, also in Pennsylvania, comes from a larger collection of points made up from two assemblages from the Gordon and Pennsylvania Museums. A total $n = 10$ points went through the caliper and morphometric analyses. The points, some possibly heavily reworked, are of more rectangular form than lanceolate, and the greatest width of the points comes at the base in the majority. As observed above, these points are more similar to the Plenge points, than the other points in the Northeast. I therefore designated these points as deep-based Northeast Clovis (Table. 5.3).

The last sample of points to go through the caliper and morphometric analyses in the Northeast was the Debert assemblage, containing $n = 5$ points [16]. Debert is in Nova Scotia, Canada. These points have already been compared to the Vail assemblage, but do vary in overall size and have a deeper basal concavity depth (Tables. 5.2, 5.3). It has been suggested that the Debert assemblage is more variable than the other assemblages in the Northeast (see Ellis 2004). When I carried out my caliper analysis on this assemblage I observed a deeper basal concavity than in the other assemblages and that the basal concavity width is also the widest of any assemblage (Table. 5.3). I classified the points from Debert as a deep-based Northeast Clovis.

[16] Whilst carrying out my geometric morphometric analysis on the Debert point assemblage, I have reason to believe that my DEB 02 specimen is in fact a Debert type point from a site in Nova Scotia called Cape Blomidon (see MacDonald 1968:124)

When comparing the assemblages across the region, my observations backed up by the caliper tests make it clear that although all assemblages adhere to many of the same basal characteristics, there are two main groups of points present in the region: the deep v-shape and u-shape Clovis fluted variants, that are present in the Vail, Debert, Bull Brook and Lamb assemblages; and the shallower-based triangular Clovis fluted variants from the Shoop and Plenge sites. Each assemblage that went through the GM was compared alongside all the assemblages in one regional graph (Figure. 5.1) with the first two PCA variables, plus the MANOVA test.

Interestingly, the three statistically similar assemblages of Bull Brook, Plenge, and Shoop share very similar toolstone patterns (Table. 5.3). Plenge has Onondaga chert and Hardyston jasper in the point assemblage. Shoop has Hardyston jasper. Bull Brook also has Hardyston jasper, while Bull Brook and Plenge both share Munsungan chert. The Lamb and Debert assemblages also reveal interesting toolstone observations. Debert relies very much on local lithic raw material, i.e. all material coming from <100 km, whereas the Lamb toolstone has travelled over >500 km, and possibly in one case 2000 km (Table. 4.2).



MANOVA TEST PAIRWISE						
	Bull Brook	**Debert**	**Lamb**	**Plenge**	**Shoop**	**Vail**
Bull Brook		fail	0.94601	0.84243	0.96021	**0.042636**
Debert	fail		fail	fail	fail	0.96208
Lamb	0.94601	fail		fail	fail	0.9703
Plenge	0.84243	fail	fail		fail	0.11567
Shoop	0.96021	fail	fail	fail		0.20967
Vail	**0.042636**	0.96208	0.9703	0.11567	0.20967	

Figure. 5.1 GM and PCA of basal concavity variation between the six site assemblages from the Northeast region and a MANOVA pairwise test on the results that compares statistical comparisons in the graph

The MANOVA test shows a comparative statistical comparison of the individual assemblages. The fail values indicate that the sample size of the assemblage was too small. So in the case of the Debert assemblage it could only be tested against Vail, which indicates that they are statistically similar (Figure. 5.1).

ASSEMBLAGE & MY ID	MY POINT IDENTIFIER	RAW MATERIAL TYPE	BASAL DESCRIPTION	MY CLOVIS POINT TYPE*
Vail, ME - VAL	VAL 01, 02, 03, 05, 07, 08, 11, 12, 13, 14, 15, 17, 18, 19, 20, 21, 22, 23, 25, 26, 28, 29.	01, 05, 08, 21; Vera Cruz jasper from PA. 02, 03, 07, 11, 12, 14, 15, 17, 18, 19, 20, 22, 23, 25, 28, 29; Normanskill chert from NY. 13, 26; Munsungan chert from ME.	deep v-shaped to u-shaped concaved base, with rounded and sharp ears	deep-based Northeast Clovis VAL 26 is a St. Louis Clovis
Bull Brook, MA - BBK	BBK 01, 02, 03, 04, 05, 07, 10, 11, 12, 13, 14, 15, 16, 17, 18, 21, 23, 26.	01, 05, 10, 11, 13, 21; rhyolite from NH. 02, 03, 04, 14, 15, 23, 26; Normanskill chert from NY. 07, 16, Munsungan chert from ME. 12, 17, 18; Hardyston jasper from PA.	slightly deep u-shaped basal concavity, with a straight-sided basal section, and triangular blade. Larger and not so deep-based as Vail	deep-based Northeast Clovis
Lamb, NY - LAM	LAM 01, 02, 03, 04, 05, 06, 07.	01; Knife River Flint from ND. 02, 03, 05, 06; Flint Ridge chert from OH. 04, 07; Upper Mercer chert from OH.	deep u-shaped basal concavity, points widest point two-thirds down point, before narrowing into basal section	deep-based Northeast Clovis
Plenge, NJ - PGE	PGE 01, 02, 03, 04, 05, 06, 07, 08, 12.	01; Munsungan chert from ME. 02, 04, 05; Hardyston jasper from NJ. 12; Onondaga chert from PA. 03, 06, 07, 08; unknown chert.	shallow / moderate u-shaped basal concavity, divergent to parallel lateral sides, and triangular to rounded blade section	deep-based Northeast Clovis
Shoop, PA - SHP	SHP 02, 03, 04, 07, 08, 09, 10, 12, 13, 14.	02, 03, 04, 07, 08, 09, 10, 12; Onondaga chert from PA. 13, 14; Hardyston jasper from PA	shallow / moderate u-shaped basal concavity, triangular blade and widest point at base	deep-based Northeast Clovis
Debert, CAN - DEB	DEB 01, 02, 03, 04, 05.	01, 03; Minas Basin chalcedony from Nova Scotia. 04; Rhyolite from Nova Scotia. 05; Sandstone from Nova Scotia. 02; unknown	deep u-shaped and y-shaped basal concavity, relatively wide basal section	deep-based Northeast Clovis

** These Clovis point types are my designations based on my observations after the caliper and morphometric / PCA analyses*

Table. 5.3 Clovis point specimens that made up my sample for the caliper and GM / PCA analyses in the Northeast region. Including my identifier, toolstone type and source, basal description and my point type definition

5.2.2 Region 2: Middle-Atlantic and Southeast

Sample: All the points, including the isolates and surface-collected points were subjected to the caliper-based metric analysis (Appendix. C). Unfortunately, due to poor sample size within the assemblages (i.e. fewer than three points), no morphometric / PCA results are available from these two subregions.

Visual observations and caliper tests: Several Clovis variants were identified from this region through my visual observations on the points, and from the caliper-based analysis (Appendix. C). The waisted Southeast Clovis, represented by points from Tennessee, Florida, and Maryland; St. Louis Clovis, from Alabama, and Kentucky; Ross County Clovis, from Arkansas, and Kentucky; an unfluted Clovis, from Maryland; and the classic Clovis, which I just call Clovis fluted, from Maryland and Virginia in the Middle-Atlantic, and Kentucky, North Carolina, and Tennessee in the Southeast (Table. 5.1; 6.2). The caliper data for these points and their photographic record are reproduced in the appendices (Appendix. C).

5.2.3 Region 3: Midcontinent and Great Lakes

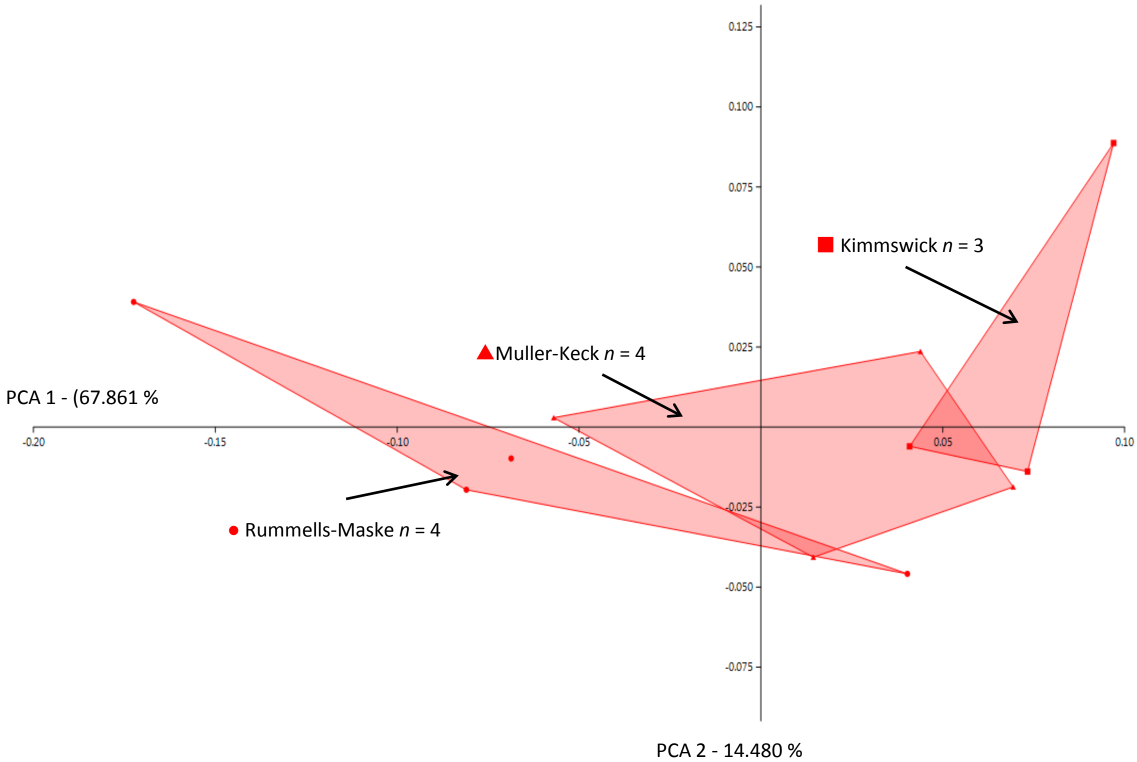
Sample: Three sites in this region were considered for the caliper and GM / PCA tests; the rest did not have a sufficient number of points in the assemblage, or were isolates (Table. 5.1). These assemblages did however go through the caliper-based process and the records of these observations are reproduced in the appendices (Appendix. C).

Visual observations and caliper tests: The first of the sites selected for the GM / PCA was Kimmswick, Missouri. There are three Clovis points recorded from this site, and all three of them were produced on separate lithic raw materials; one very local, and the other two considered local (Table. 4.2). During the caliper analysis, I observed that the points displayed straight to convex lateral sides and a shallow concave base, with both lateral and basal grinding after fluting. It was reported that one point in particular, KL-L22-32 (KIM 01) was strikingly similar in both size and flaking to two from Blackwater Draw, New Mexico, and one from Naco, Arizona (Graham *et al.* 1981:1115). These points will be re-classified, as some archaeologists call these western Clovis; I have termed these simply as Clovis fluted (Tables. 5.4; 6.2).

The Rummells-Maske assemblage from Iowa, has at least twenty-two Clovis points that are curated into three separate collections; two that belong to the Rummells and Maske families, and one that is housed in a museum. The site has recently been interpreted as being a cache (Morrow and Morrow 2002; Morrow 2017b) since its last detailed analysis in the late 1990s; therefore many of the references to the site still have it designated as a campsite. I included $n = 5$ points in the caliper analysis after having to deselect a specimen (RMK 05) due to the basal section being too heavily damaged. I was left with four for the morphometric analysis. The Rummells-Maske points all display technological characteristics similar to the traditional Clovis form. However, all the points including the damaged specimen, display a deeper basal concavity than is usually seen in Clovis fluted points, not too dissimilar to some of the northeastern deep-based points. Morrow reported (Morrow and Morrow 2002b) the average basal concavity depth of the whole assemblage is 7.4 mm, which is considerably more than the average Clovis point, and has suggested these points are more comparable to the Gainey points [17] in Michigan (Simons *et al.* 1984), and the Lamb points from New York (Gramly 1999). My caliper analysis suggests that these points vary very slightly from each other and all produced on the same toolstone. Therefore, it may be that this is just the work of a single knapper. After my observations I designated the whole assemblage as a Clovis fluted form (Figure. 5.2; Table. 5.4).

[17] The Clovis-aged fluted points from the Great Lakes area in the Midcontinent have frequently been described as Gainey (see Simons *et al.* 1984; Morrow and Morrow 2002a) as well as the unhelpful classification of them as Folsom-like

The third assemblage that underwent the caliper and morphometric tests was the Mueller-Keck site in Illinois. The twin-campsite at Mueller and Keck has produced many Clovis points; my sample of n = 4 points, is very typical of the style of the entire assemblage, although in my literature review I did observe some points that demonstrated characteristics similar to Ross County Clovis and St. Louis Clovis types (see Koldehoff and Amick 2008). The points in my measurement analysis are lanceolate in form and have their widest point two thirds down the body of the point, roughly the start of the basal section, are laterally and basally ground, and have a shallow basal concavity (Tables. 5.2, 5.4).



MANOVA TEST PAIRWISE
No Test Possible - Sample of points in each assemblage too few to register

Figure. 5.2 GM analysis of basal concavity variation between the site assemblages from the Midcontinent and Great Lakes region and a MANOVA test on the results that compares statistical comparisons in the graph

The GM / PCA tests indicate that although the assemblages show some similarities overall, there is enough variation within the individual assemblages for them to be different (Figure. 5.2); the Rummells-Maske points being slightly different from each of the other assemblages, but being the most similar to those others in their own assemblage. Because of small sample sizes these observations must be viewed with caution (Table. 5.4; Appendix. C).

The patterns in the toolstone used between these sites could be down to the site type. The Rummells-Maske assemblage has been classified as a cache, with some campsite behaviour, Muller-Keck is a campsite, and the toolstone sourcing and movement patterns are similar to those from the Northeast region. Whereas the Kimmswick assemblage belongs to a kill site, and much more local toolstone may have been necessary or available at the time.

ASSEMBLAGE & MY ID	MY POINT IDENTIFIER	RAW MATERIAL TYPE	BASAL DESCRIPTION	CLOVIS TYPE
Kimmswick, MO - KIM	KIM 01, 02, 03.	01; St. Genevieve chert from MO. 02; Burlington chert from MO. 03; Fern Glen chert from MO.	shallow concave bases and has basal and lateral grinding, characteristics very similar to the type specimens	Clovis fluted
Rummells-Maske, IA - RMK	RMK 01, 02 ,03, 04, 05.	01, 02,03, 04, 05; Burlington chert from IA.	quite deep u-shaped basal concavity, but other characteristics are consistent with Clovis	Clovis fluted
Mueller-Keck, IL - MUK	MUK 01, 02, 03, 04.	01, 02, 03, 04; Attica chert from IL.	shallow concave base with other characteristics consistent with Clovis	Clovis fluted

Table. 5.4 Clovis point specimens that made up my sample for the caliper and GM / PCA analyses in the Midcontinent and Great Lakes region. Including my identifier, toolstone type and source, basal description and my point type definition

5.2.4 Region 4: Northern Plains

Sample: The Northern Plains region sample is made up of four assemblages, three of which are caches, the other being a kill site. The four assemblages were subjected to caliper and GM / PCA. All three of the cache assemblages represent different Clovis cultural behaviour and the variability of the points and raw materials is discussed below.

Visual observations and caliper tests: The Colby assemblage, a kill site in Wyoming, is a small but unique sample, $n = 4$, in that all the points display a distinctive rounded-eared deep-based concavity, quite different to those deep-based points from the Northeast, and all the points display lateral and basal grinding (Table. 5.5). The caliper analysis shows that these points have their widest point where the rounded ears start (Table. 5.2). Although these points vary in the basal sections when compared to the to the Clovis fluted point, the technology and manufacture are distinctively Clovis (Frison and Bradley 1999), and they were also directly associated with a mammoth kill. The geometric morphometric / PCA results revealed that although these points are quite different to other Clovis point assemblages in the region (Figure. 5.3), they are very similar to two points in the Fenn cache (FEN 03, 04). I have designated these points deep-based Northern Plains Clovis.

The Drake cache assemblage from Colorado, $n = 13$, are all very similar in technological manufacture and shape; their caliper-based measurements analysis also show very little variation (Table. 5.2). The cache is mainly made up of finished points; all display a shallow basal concavity and exhibit similar characteristics to the Clovis type description from New Mexico and Arizona (Tables. 5.4, 5.5). I have designated these points Clovis fluted. It may be significant that this cache had long distance imports of the high quality Texas Alibates and Edwards chert toolstone (Holen 2014).

The Anzick cache in Montana, however, is quite different, in that it has an assemblage of points, preforms and other lithic artefacts, osseous rods, and even perhaps a Clovis-age burial (Rasmussen *et al.* 2014). The points in my sample, $n = 5$, are quite different in general appearance and their caliper-based results (Table. 5.2), but do have a similar basal morphology. The points are triangular in blade and body sections, and have a very shallow basal concavity, the most shallow I have recorded from all regions (Table. 5.5). The geometric morphometric / PCA shape analysis of the bases also support this interpretation, (Figure. 5.3), and I designate these points as a flat-based Clovis form.

The final cache and point assemblage to undergo the caliper measurements and morphometric analysis is the Fenn cache from somewhere along the Wyoming border. My sample, $n = 7$, is very typical of the overall point count from the site. This cache is different again in that it contains around sixty lithic artefacts, mainly Clovis points, bifaces and preforms. The points are not all similar to each other like the previous caches mentioned above. It also has a number of toolstone types, with the obsidian representing extreme long distance movement of raw material of over 1000 km away in central Colorado (Table. 4.2). The caliper-based analysis revealed there were two points from my sample that displayed the same characteristics as those from the Colby site, and these will be classified as deep-based Northern Plains Clovis forms (Table. 5.5).

The Fenn cache has been the subject of some controversy since its reported discovery in the early 1900s. In the previous chapters I suggested that due to some of the point styles present in the assemblage, it could not be the subject of modern replicators or forgers. I do, however, propose that it is quite possible that points were found prior to the discovery and placed in a cache-like situation, either by modern collectors or even Native American Indians who have been known to curate ancient objects and artefacts (Hudson and Blackburn

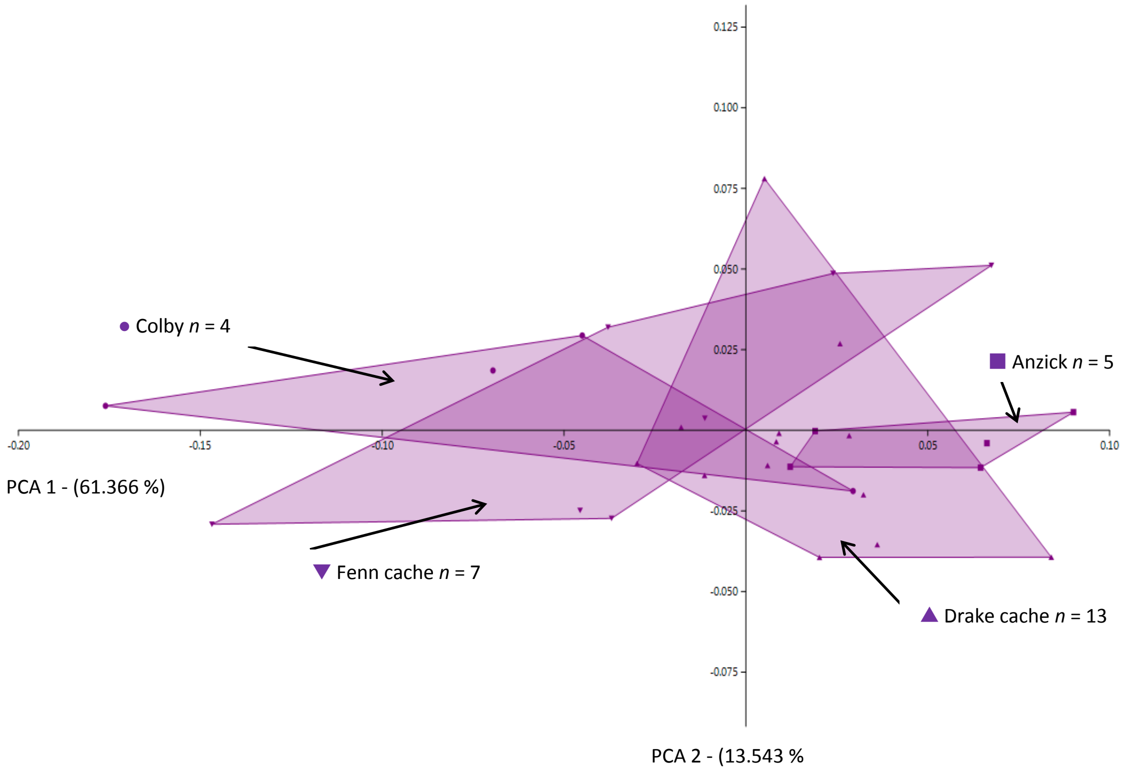
1980)[18]. The Fenn cache has no similarity to the other point caches in other regions, where there is only one point style present, and a predominant toolstone *e.g.* Simon, Idaho; Drake, Colorado; East Wenatchee, Washington, etc. Additionally the extent of toolstone is also surprising, as the other caches have only one or two toolstone varieties present.

ASSEMBLAGE & MY ID	MY POINT IDENTIFIER	RAW MATERIAL TYPE	BASAL DESCRIPTION	CLOVIS TYPE
Drake, CO - DRK	DRK 01, 02, 03, 04, 05, 06 ,07, 08, 09, 10, 11, 12, 13.	01, 02, 03, 04, 05, 06, 08, 09, 10, 11, 12; Alibates chert from TX. 07; Edwards chert from TX. 13; White River chalcedony from WY.	shallow concave base that also exhibits some consistent with the type description of Clovis basal grinding.	Clovis
Anzick, MT - ANZ	ANZ 01, 02 ,03, 04, 05.	01, 02; Amsden chert from WY. 03; Moss agate from WY. 04, 05; Hartville chert from WY.	very shallow, almost flat distal end, lateral and basal grinding present	flat-based Clovis
Fenn, UT/WY/ID - FEN	FEN 01, 02, 03, 04. 05, 06, 07.	01, 02, 03; Smokey quartz from CO. 04; Malad obsidian from ID. 05, 07; Utah agate from UT. 06; Amsden chert from WY	relatively deep-basal concavity, basal and lateral grinding present	Clovis FEN 03, 04 are deep-based Northern Plains Clovis
Colby, WY - CBY	CBY 01, 02, 03, 04	01, 03, 04; Amsden chert from WY. 02; Madison chert from WY.	deep-based, rounded-eared basal concavity, basal and lateral grinding	deep-based Northern Plains Clovis

Table. 5.5 Clovis point specimens that made up my sample for the GM and PCA analysis in the Northern Plains region. Including my identifier, toolstone type and source, basal description and my point type definition

In my PCA for this region I compared all three caches along with the Colby kill site (Figure. 5.3). The results of the GM / PCA indicate that the caches are indeed morphologically different from each other, with some comparable variation within the Fenn cache: the Fenn assemblage having some similarity with the Colby assemblage. Unfortunately with only the Drake assemblage having more than $n = 7$ points in the assemblage, the MANOVA test failed.

[18] In my comparative analysis: sample 2); there is a isolate Clovis point (NEZ 01) which was found by a U.S. Army surgeon (Potter and Aegeson 1974) on the Nez Perce Indian Reservation in 1869 (Appendix. C)



MANOVA TEST PAIRWISE				
	Anzick	**Colby**	**Drake**	**Fenn**
Anzick		fail	fail	fail
Colby	fail		fail	fail
Drake	fail	fail		fail
Fenn	fail	fail	fail	

Figure. 5.3 GM basal point shape analysis of basal concavity variation between the site assemblages from the Northern Plains region and a MANOVA test on the results that compares statistical comparisons in the graph

The toolstone patterns reveal that Amsden cherts are present in the Anzick and Fenn caches, as well as the kill site at Colby. It may be that Clovis groups were moving around the region caching complete points for later retrieval, which would be in line with the popular thinking for caches in the Northern Plains (see Kilby 2014a). However, the three cache sites from this region differ uniquely in their own right. The Drake cache is made up of thirteen, seemingly unused Clovis points made on a predominant toolstone and showing little variability. The Anzick cache has a distinctive Clovis point type, and could be a Clovis-aged burial. Whereas the Fenn cache Clovis point element shows considerable variability, and are made on several toolstone types, plus the cache has doubts surrounding the original deposition of the Fenn cache material, and the later discovery.

5.2.5 Southern Plains and Desert Southwest

Sample: This regions sample is made up of six assemblages, and all of them are either kill sites or have a kill site element associated.

Visual observations and caliper tests: The first of these assemblages to be looked at is the Clovis-aged bison kill site, Jake Bluff, Oklahoma. There are four Clovis points in the entire assemblage, and I managed to get access to three of them for this study [19]. All three of the points I had access to were subjected to caliper analysis and morphometric shape analysis. The basal concavities of these points were very similar, with a regular curvature becoming relatively steep at the deepest point of the basal depth (Tables. 5.2, 5.6). The points all had basal and lateral grinding, and were made from lithic raw materials from Texas and Nebraska (Table. 4. 2). I designated all four of the points in this assemblage as Clovis fluted.

The second assemblage was from the Miami mammoth kill site in Texas. Relatively few artefacts were recovered, but there were three Clovis points. Two were made from Texas Alibates chert and the third from a grey quartzite. All three points were part of this study and underwent the caliper and geometric morphometric / PCA process (Figure. 5.4; Table. 5.6). All three points are similar in morphology and have basal and lateral grinding. I have designated these points Clovis (Table. 5.2).

[19] The fourth Clovis fluted point was found to have traces of bear protein residue on the blade section (Yost 2007), and bear remains were recovered in the bonebed. This is the first direct association of humans exploiting bears (Bement and Carter 2010). Although there have been bones of bear found in other Clovis sites in North America (see Haynes and Huckell 2007)

The third, fourth, and fifth assemblages come from the mammoth kill event in the San Pedro Valley, Arizona. Lehner is a mammoth kill site and the assemblage of $n = 8$ points represents the sample I used. I had to reject two points as the basal section was missing, and the three miniature quartz crystal points as these would not resemble the true point forms present in this assemblage (Tables. 5.2, 5.6). Naco was also a mammoth kill, but the individual roamed off and died of its wounds a few kilometres away. The Clovis group evidently did not go in pursuit, and the mammoth carcass with eight Clovis points was covered soon after death by sediments. Once again I had to reject one point for its missing basal section. All fifteen points are very similar in both technology and form. The same raw materials were used to produce the points in both assemblages (Table. 5.6), and both the caliper averages and the morphometric shape analysis support these findings quite nicely as both assemblages are almost indistinguishable in both morphology and technology (Appendix. C). I classified these points from the two assemblages as Clovis fluted.

Murray Springs has been classified as a kill /camp, with a habitation and processing areas, along with horse and bison butchery, as well as mammoth kills. The lithic assemblage is much larger than the other two sites, as is expected at a campsite. The Clovis points vary considerably in size and basic shape, and the metric and morphometric tests support those observations, whilst still retaining the Clovis fluted point characteristics (Figure. 5.4). From an original sample of $n = 15$ points, I was left with $n = 6$ after my selection process. Interestingly, all three of the Clovis point assemblages were produced on (regionally) local toolstone types (Tables. 4.2; 5.6). There is also a toolstone - unnamed pinkish red and grey chert; present in all assemblages, which suggests there is a definite group association between them (see Haynes 2007).

The final assemblage from this region to be tested is from the Clovis type site at Blackwater Draw, New Mexico. The actual number of Clovis points from this site is unknown, as there have been numerous excavations and private collectors taking points from the location since its discovery in the early 1930s. I had an original sample of *n* = 29 before my selection process, and was left with a final sample of *n* = 19 (Table. 5.1). It has already been well-documented that this site contained two Clovis fluted point forms (Hester 1972) [20]. Hester described one variant as his 'Clovis Type 1'. These points were similar in size and form to the points discovered at the Lehner, Naco, and Miami kill sites. The other variant, the 'Clovis Type 2' point, was first documented by Hester (1972:97). These points demonstrate the same technological characteristics as the Type 1 points, but differ in size, with their overall length typically between 20 mm to 45 mm. The other difference being that they have a triangular blade, with the widest part of the point at its base. Originally thought to be older, the direct association of these points with the mammoth remains established their Clovis association. In my sample I included nine Type 1 points, and ten Type 2 points; they all underwent the caliper and GM / PCA tests (Figure. 5.4; Tables. 5.2, 5.6) and were all designated Clovis fluted points, as I found no significant variations in the assemblage. The main overriding difference between the Type 1 and Type 2 Clovis points is their size, not in basal concavity variation.

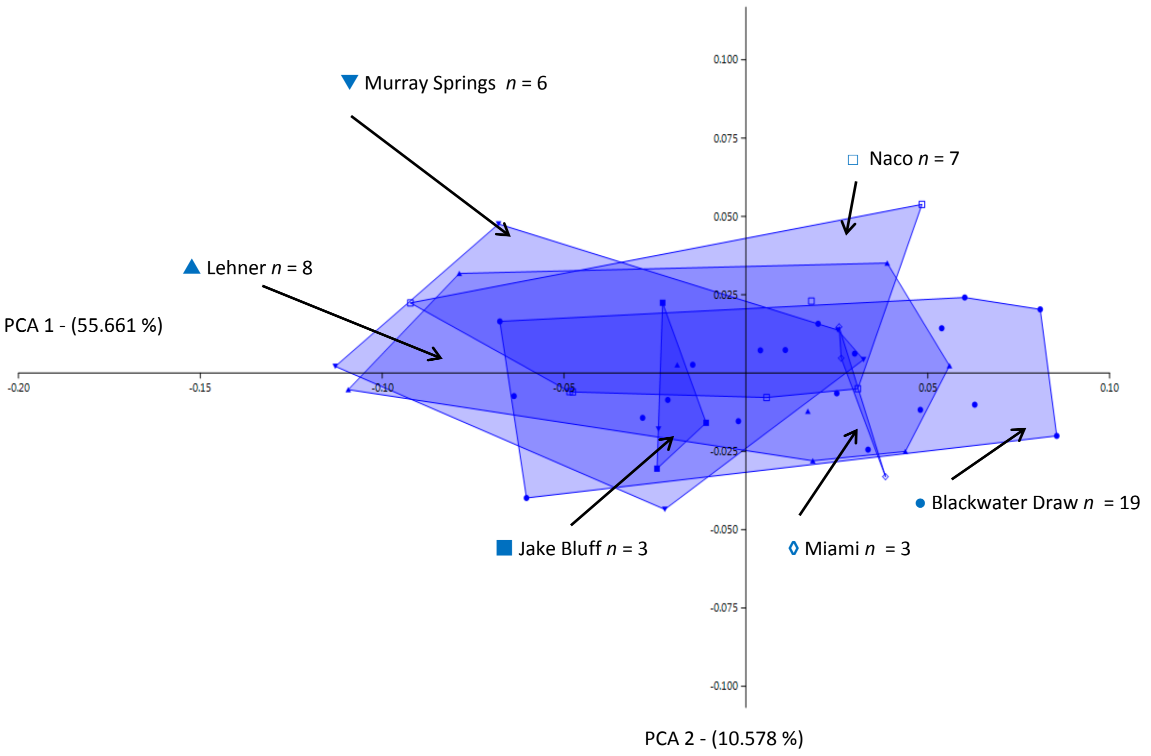
The Blackwater Draw assemblage is visually very variable, but both my caliper analysis and the morphometrics on this assemblage show very little variability in the basal concavity of these points, and statistically they show very little variation (Figure. 5.4; Table. 5.6). I interpret this as different Clovis groups converging on the waterhole at Blackwater Draw from within the region, and outside, and discarding the Clovis fluted point forms there. The raw material patterns from this site are interesting, in that the toolstone comes from different directions and sometimes from different regions (Figure. 4.5; Table. 4.2). This is opposite to

[20] These two variants that Hester describes should not be confused with Cotter's Type I-Specimen, and Type II-Specimen (Cotter 1937) which were two particular fluted points found at the Clovis type site which became known as Blackwater Draw Locality No. 1 in New Mexico

what was occurring at the campsite at Murray Springs where the same groups were using the same toolstone to produce their points.

ASSEMBLAGE & MY ID	MY POINT IDENTIFIER	RAW MATERIAL TYPE	BASAL DESCRIPTION	CLOVIS TYPE
Jake Bluff, OK	JBF 01, 02, 03.	01; Dakota quartzite from NE. 02, 03; Alibates from TX.	all points have a similar basal concavity, with a regular curvature coming to a relatively steep max depth	Clovis fluted
Miami, TX	MIA 01, 02, 03.	01; Tecovas quartzite from TX. 02, 03; Alibates chert from TX.	regular curvature of the basal concavity, but all quite shallow	Clovis fluted
Lehner, AZ	LEH 04. 05, 06, 07. 08, 09, 11, 13.	04, 09, 11; St. David chalcedony from AZ. 05, 06, 07, 08, 13; Unnamed chert and chalcedony from AZ.	some variation in shape but basically the basal concavity and depth are consistent.	Clovis fluted
Naco, AZ	NAC 01, 02, 03, 04, 06, 07, 08.	01, 03, 04, 06, 07; Unnamed chert from AZ. 02, 08; Unnamed felsite from AZ	As above	Clovis fluted
Murray Springs, AZ	MSP 03, 04, 05, 07, 09, 11.	03, 05, 11; Unnamed chert from AZ. 04; Cow Canyon obsidian from AZ. 07, 09; St. David chalcedony from AZ.	As above however there is far more shape variation in the basal sections than in the two previous assemblages	Clovis fluted
Blackwater Draw, NM	BWD 01, 02, 03, 04, 06, 07, 08, 09, 11, 12, 13, 16, 23, 24, 25, 26, 27, 28, 29.	01, 02, 06, 07, 24, 26; Edwards chert from TX. 03, 04, 08, 11, 13, 16, 23, 27, 29; Alibates chert from TX. 09, 12; Tecovas jasper from TX 25; Wild Horse Canyon obsidian from UT. 28; Tecovas quartzite from TX	there are two sizes of points in this assemblage, but the basal concavities and depths have been part of the same analysis. The larger points display short flutes and a shallow concave base. The smaller points are widest at the base and display slightly shallower concavity.	Clovis fluted Type-1 points: 01, 02, 03, 04, 06, 16, 24, 25, 28. Type-2 points: 07, 08, 09, 11, 12, 13, 23, 26, 27, 29.

Table. 5.6 Clovis point specimens that made up my sample for the GM and PCA analyses in the Southern Plains and Desert Southwest region. Including my identifier, toolstone type and source, basal description and my point type definition



MANOVA TEST PAIRWISE						
	Blackwater Draw	**Jake Bluff**	**Lehner**	**Miami**	**Murray Springs**	**Naco**
Blackwater Draw		fail	0.97049	fail	0.98723	0.92524
Jake Bluff	fail		fail	fail	fail	fail
Lehner	0.97049	fail		fail	fail	fail
Miami	fail	fail	fail		fail	fail
Murray Springs	0.99723	fail	fail	fail		fail
Naco	0.92524	fail	fail	fail	fail	

Figure. 5.4 PCA of basal concavity variation between the site assemblages from the Southern Plains and Desert Southwest region and a MANOVA test on the results that compares statistical comparisons in the graph

5.2.6 Southwest and Great Basin

Sample: I only managed to get one assemblage of Clovis points from this region that I could put through the GM / PCA tests (Figure. 5.5) I did manage to get access to an isolate surface-collected Clovis point from the Dugway Military Base in Utah which was part of my caliper assessment (Appendix. C).

Visual observations and caliper tests: The assemblage of Clovis points is from the well-documented Borax Lake site in California, which has been interpreted as a campsite. The entire assemblage of Clovis points is made up of just basal sections, and after I had rejected the specimens that were too damaged I was left with a sample of $n = 4$ (Tables. 5.1, 5.2, and 5.7). Originally the site and the fluted points were identified as being Folsom[21] (Harrington 1948); subsequent research, particularly Haynes (Meighan and Haynes 1970), classified the Borax Lake fluted points as being typically Clovis in size, shape, and workmanship. Three of the four basal sections in my sample were made from local obsidian (Tables. 4.2; 5.7) and during my caliper analysis on the assemblage I noticed scratches and abrasions on the fluted surface, traces of evidence for the hafting of the points (see Slade in press a). After my analysis on the assemblage I designated the points as Clovis fluted.

The fact that the Borax Lake is a campsite, and that the point assemblage is completely made up of just basal fragments, could be an indication that retooling and maintenance were major activites at this site.

ASSEMBLAGE & MY ID	MY POINT IDENTIFIER	RAW MATERIAL TYPE	BASAL DESCRIPTION	CLOVIS TYPE
Borax Lake, CA	BXL 01, 02, 04, 05.	01; Franciscan Bay chert from CA. 02, 04, 05; Borax Lake obsidian	edge grinding was present on all bases. The bases are concave and expand in width towards the distal end of the point	Clovis fluted

Table. 5.7 Clovis point specimens that made up my sample for the GM and PCA analyses in the Southwest and Great Basin region. Including my identifier, toolstone type and source, basal description and my point type definition

[21] Harrington originally identified the Borax Lake material as being Folsom, as the typological distinction between Folsom and Clovis had not been made at that time. C.V. Haynes Jr. later identified the points as being typically Clovis (Meighan and Haynes 1970)

5.2.7 Northwest

Sample: The final region to be looked at is the Northwest, and like the previous region I only had one Clovis point assemblage that fitted the morphometric analysis sample criteria, but unlike the Southwest, there were other sites and assemblages that could be analysed using the calliper approach (Table. 5.1; Appendix. C).

Visual observations and caliper tests: The Simon cache in Idaho consists of over thirty bifacial tools, nine of which can be classified as fluted points. My sample, $n = 4$, of these points made up the only morphometric test in this region, and I decided to compare this cache assemblage with other cache assemblages from my sample (Figure. 5.5). The calliper analysis of these points revealed that they were some of the largest and longest fluted points in my study (Table. 5.2; Appendix. C) [22]. Three of the points were the longest, and came in at between 159 mm and 180 mm. The basal concavities are relatively shallow considering their size.

[22] The longest Clovis fluted points, possibly hafted knives, are from the East Wenatchee cache in Washington (Gramly 1993), but the largest and longest Clovis fluted point ever recorded comes from Badger Mountain, a few km from the East Wenatchee cache (Gramly 1993: 27)

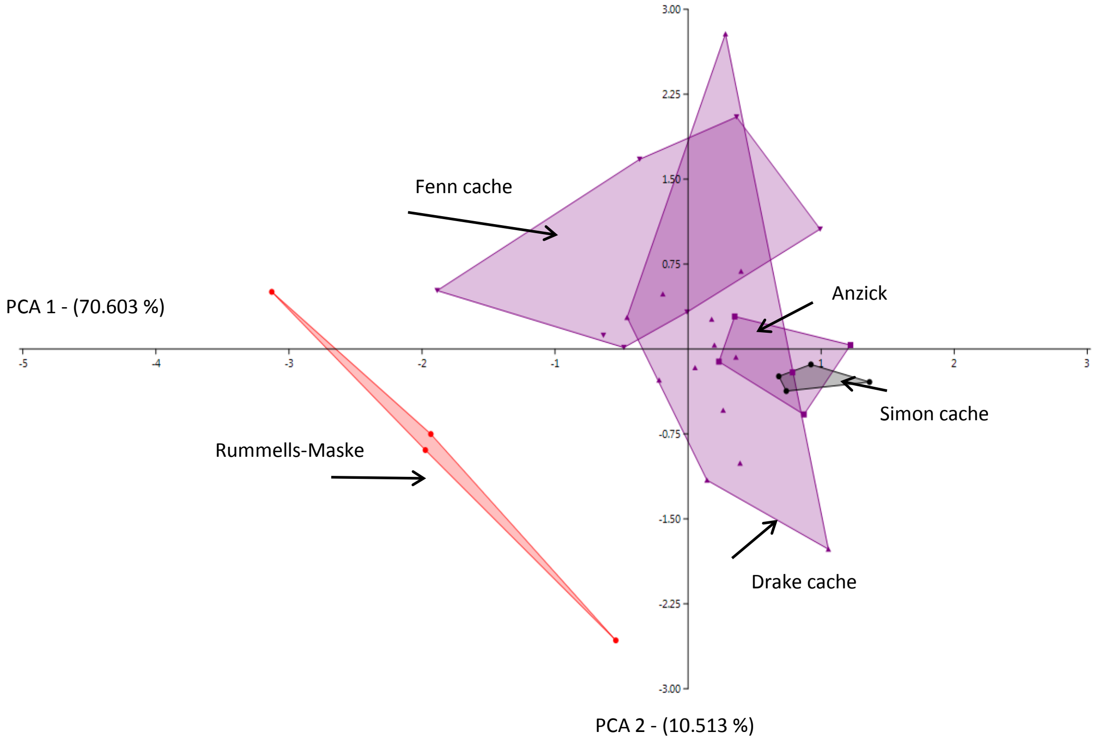


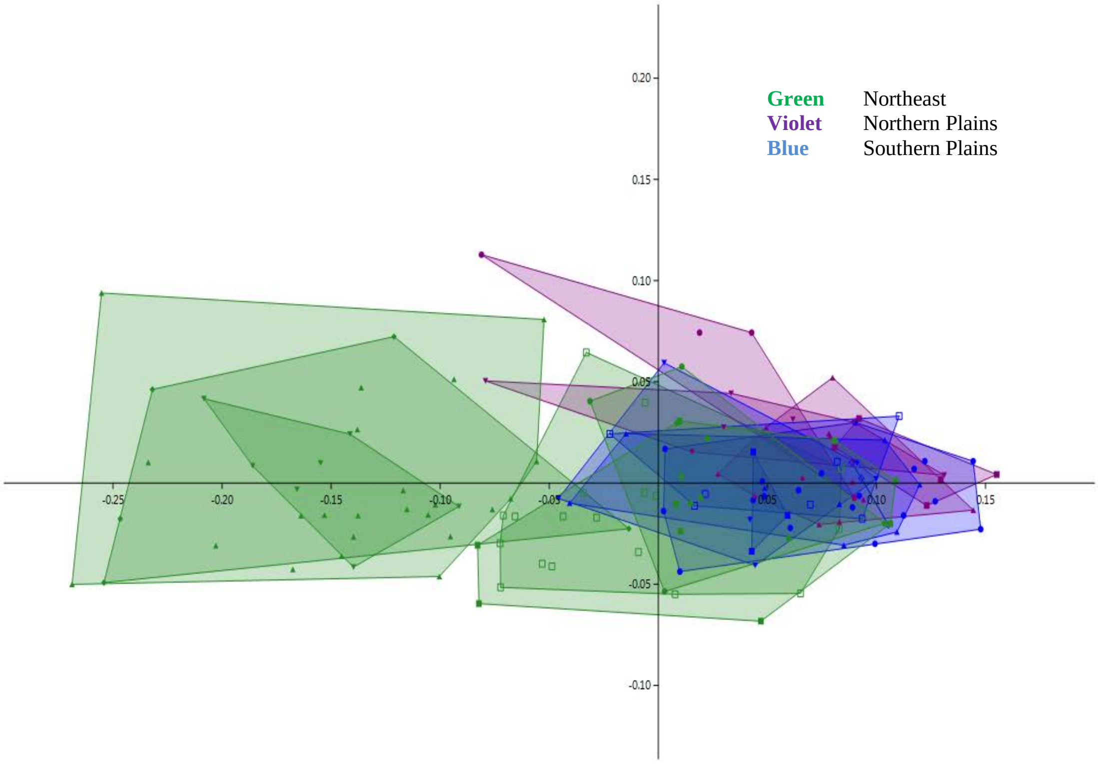
Figure. 5.5 PCA of basal concavity variation between the Clovis cache sites of the Northern Plains graph, Northwest graph and Midcontinent and Great Lakes graph regions as an interesting comparative test

The points in my sample, and those I did not get access to, are very similar to each other technologically as well as morphologically. The geometric morphometric / PCA results supported this completely, in that when I compared the Simon cache with the other caches that also were individually quite distinctive themselves, the Simon assemblage stood out as very distinctive. However, the most interesting result was that of the Rummells-Maske cache (Figure. 5.5), which showed very little variability within its own assemblage, but which is morphologically discrete according to the GM / PCA results from the other cache assemblages.

5.3 Synopsis: brief overview of the results

Combining my findings from the caliper-based analysis and the morphometric shape tests with the observations from the raw material analysis in the previous chapter, it is now possible to see how these results impact on my research question. The final conclusions and summing up will be made in the next chapter, but it will be briefly discussed here as a conclusion to the last two chapters.

In Chapter 4, I concluded by showing my observations and expectations (see Table. 6.1) of how the raw material sourcing and movement impacted on the regional Clovis groups and their production of fluted points. In this chapter I have presented the statistical data on the Clovis fluted point assemblages that made up my complete sample, i.e. sample 1) M; sample 2) C; and sample 3) S. Although some regions were underrepresented with undersized assemblages, and in some cases did not produce any Clovis assemblages for the GM analysis to be carried out, I believe that the overall metrical analysis on my sample (Appendix. C), the GM / PCA analyses, and the interpretation of the archaeological record in Chapter 2, provide a good enough test for my hypothesis.



MANOVA TEST PAIRWISE															
	Anzick	**Bull Brook**	**Blackwater Draw**	**Colby**	**Debert**	**Drake**	**Fenn**	**Jake Bluff**	**Lamb**	**Lehner**	**Miami**	**Murray Springs**	**Naco**	**Plenge**	**Shoop**	**Vail**
Anzick		fail	0.99997	fail	fail	fail	fail	fail	fail	fail	fail	fail	fail	fail	fail	0.49069
Bull Brook	fail		0.24492	fail	fail	0.46393	0.96452	fail	0.9431	0/.98558	fail	0.9946	0.9752	0.97122	0.95492	0.029052
Blackwater Draw	0.99997	0.24492		fail	0.92157	0.96636	0.98798	fail	0.6734	0.99641	fail	0.99614	0.99045	0.97401	0.94173	0.0039118
Colby	fail	fail	fail		fail	fail	fail	fail	fail	fail	fail	fail	fail	fail	fail	0.78537
Debert	fail	fail	0.92157	fail		fail	fail	fail	fail	fail	fail	fail	fail	fail	fail	0.94902
Drake	fail	0.46393	0.96636	fail	fail		fail	fail	fail	fail	fail	fail	fail	fail	fail	0.011065
Fenn	fail	0.96452	0.98798	fail	fail	fail		fail	fail	fail	fail	fail	fail	fail	fail	0.39865
Jake Bluff	fail	fail	fail	fail	fail	fail	fail		fail	fail	fail	fail	fail	fail	Fail	0.91269
Lamb	fail	0.9431	0.6734	fail	fail	fail	fail	fail		fail	fail	fail	fail	fail	fail	0.97853
Lehner	fail	0.98558	0.99641	fail	fail	fail	fail	fail	fail		fail	fail	fail	fail	fail	0.28272
Miami	fail	fail	fail	fail	fail	fail	fail	fail	fail	fail		fail	fail	fail	fail	0.83826
Murray Springs	fail	0.99946	0.99614	fail	fail	fail	fail	fail	fail	fail	fail		fail	fail	fail	0.59259
Naco	fail	0.9752	0.99845	fail	fail	fail	fail	fail	fail	fail	fail	fail		fail	fail	0.40544
Plenge	fail	0.97122	0.97401	fail	fail	fail	fail	fail	fail	fail	fail	fail	fail		fail	0.27394
Shoop	fail	0.95492	0.94173	fail	fail	fail	fail	fail	fail	fail	fail	fail	fail	fail		0.15956
Vail	0.49069	0.029052	0.0039118	0.78537	0.94902	0.011065	0.39865	0.91269	0.97853	0.28272	0.83826	0.59259	0.40544	0.27394	0.15956	

Figure. 5.6 PCA of basal concavity variation between the site assemblages from the Northeast, Northern Plains, and Southern Plains regions. Plus a MANOVA test on the results that compares statistical comparisons in the graph

A GM / PCA test on basal shape analysis provided a comparison from the three regions that produced the best-sized sample assemblages of Clovis points (Figure. 5.6). The Northeast region, represented by the green assemblages in the graph, are mainly made up of Clovis campsites and appear to be statistically different to the Clovis cache sites of the Northern Plains coloured violet, and the kill sites of the Southern Plains in blue. There is a similarity within all three groups, where the site types and assemblages overlap. With the largest variation coming from within the campsites of the Northeast, where it has already been observed above there were two statistically different outcomes from the morphometric analysis (Figure. 5.6).

Finds of fluted points at the Clovis type site at Blackwater Draw Locality No.1, and a handful of other sites, resulted in recognition of a Clovis type that is based for the most part on large, straight-sided lanceolate bifacial points, displaying a single or multiple flute that rarely extends more than a third up the way of the body of the point, and which have slightly concave bases (*e.g.* Sellards 1952; Howard 1990; Justice 1995). I have identified these points from the assemblages that made up my complete sample and have classified these points as Clovis points. They differ from the many other assemblages that have been called and have now been identified in this study as a particular Clovis variant (Table. 6.2).

5.4 Summary: observations and implications

In Chapter 2 I demonstrated what the current regional distribution of Clovis points and Clovis variants were, and how they were defined in the archaeological record (Table. 2.3). In this summary I will present my new point definitions after reclassification (Table. 5.8), how the patterns from the results of my analysis on the points support my conclusions in Chapter 6, and where I will look at each region separately and in more depth.

POINT WITH NEW CLASSIFICATION	FORM / TYPE	REGIONAL DISTRIBUTION	KEY SITES	COMMENTS AND DESCRIPTION	PRIMARY SOURCE
Classic Clovis: Figure. 2.1 (a-f) **Slade classification: Clovis fluted**	Clovis type point	all regions, but the majority are found in the Northern and Southern plains, Desert Southwest and Midcontinent	Blackwater Draw, NM; Miami, TX, San Pedro Valley sites, AZ; Dent, CO, Kimmswick, MO	lanceolate fluted point, slightly concave base and base and lateral grinding	Wormington (1957) Hester (1972) Howard (1990)
Colby Clovis - Deep-based Clovis: Figure. 2.2 (b) **Slade classification: deep-based Clovis**	Clovis variant	Northern Plains	Colby, WY; Fenn Cache, UT/WY/ID border	deep basal concavities and rounded basal ears	Frison (1978)
Debert / Vail Clovis - Deep v-based Clovis: Figure. 2.2 (c) **Slade classification: deep-based Clovis**	Clovis variant	Northeast	Debert, Nova Scotia; Vail, ME; Bull Brook, MA; Lamb, NY	deep v-shaped to u-shaped concave bases	McDonald (1968)
Bull Brook Clovis - Triangular blade Clovis: Figure. 2.2 (d) **Slade classification: deep-based Clovis**	Clovis variant	Northeast	Bull Brook II, MA; Shoop, PA; Plenge, NJ	medium to small parallel-sided to triangular blade section	Byers (1954)
Anzick Clovis - Straight-based Clovis: Figure. 2.2 (a) **Slade classification: flat-based Clovis**	Clovis variant	Northern Plains	Anzick, MT	large triangular with a straight basal edge. Typically short flutes in relation to overall length	Wilke *et al.* (1991)
Ross County - Waisted Clovis style: Figure. 2.2 (e) **Slade classification: Ross County Clovis**	Clovis variant	Midcontinent & Great Lakes	Hardin County, OH; Pike County, IL; Clay County, AR	thick medium sized points with the widest part in the mid-section.. lateral edges constrict towards basal corners	Prufer & Baby (1963)
Waisted Clovis - Southeast Clovis: Figure. 2.2 (e) **Slade classification: waisted Clovis**	Clovis variant	Middle-Atlantic & Southeast, Southern Plains, Desert Southwest	Silver Springs and Sloth Hole, FL; Camp Pecomoth, MD; Gault and McFaddin Beach, TX; Murray Springs, AZ	see Ross County for description	Neill (1958)
St. Louis Clovis Figure. 2.2 (f) **Slade classification: St. Louis Clovis**	Clovis variant	Midcontinent & Great Lakes, Middle-Atlantic & Southeast	Belgreen, AL	large thin fluted point, convex sides contracting to the basal edge, wide flat flutes	Perino (1985)
Western Clovis **Slade classification: Clovis fluted**	Clovis variant	Southwest & Great Basin	Borax Lake, CA	originally named a crude form of Folsom, it is fluted and has concave bases	Harrington (1948)
Unfluted Clovis **Slade classification: unfluted Clovis**	Clovis variant	Southern Plains and Desert Southwest, Middle-Atlantic & Southeast, Southwest	Bull Creek, OK; Bigbee, NM; Page-Ladson, FL; Fenn Cache, UT/WY/ID border	typically very similar to the Clovis fluted form without the fluting	Haynes (1955) Frison and Bradley (1999) Puseman (2004) Dunbar (2006, 2007) Thomas *et al.* (2017)

Table. 5.8 Clovis variants that have been renamed and reclassified after my observations and interpretation of the analysis (see Table. 2.3)

During this research I decided to drop several terms that had been, and still are being, used in the literature to describe Clovis fluted points, or Clovis-aged variants. As discussed above, the geographic extent of Clovis also remains unclear. The broadly defined description for Clovis had regional variants. The term 'Gainey' has been used to describe the earliest fluted point technology in the Midcontinent / Great Lakes region. Morrow (2014b) bases her argument on the subtle differences in the flaking technology between Clovis and Gainey points. Whereas Eren and Desjardine (2014) argue that, due to the broader assemblage, it is clearly Clovis, and the term Gainey should be dropped. I designated all the Gainey referenced points in my analysis as being Clovis.

I also dropped the term 'Western' when used to describe the traditionally termed classic Clovis form from the Great Plains and southwestern United States, which I termed the Northern Plains region, and the Southern Plains and Desert Southwest subregions. I found this term extremely ambiguous, and confusing. When using the term 'Western' some researchers are referring to fluted points from the Great Basin, i.e. 'Western Fluted' (*e.g.* Grayson 2011:289), and even more confusingly, other researchers used the term when describing the points from western North America, i.e. any Clovis sites that were apparently west of the Mississippi River (*e.g.* Morrow 2005a:51). Therefore, when interpreting the archaeological record, one could be being directed to points that resemble Clovis in the Great Basin or from the Great Plains.

Bradley *et al.* (2010) in attempting to describe a typical Clovis material culture refered to them as 'Classic Clovis'. Miller *et al.* suggested the context of these sites as being "*highly variable"* and argued that most Clovis sites can be put into five catagories. I agree in part with some of Miller *et al.* (2013) site catagories that are set out below:-

1) fluted-point sites associated with extinct fauna
2) sites with Clovis points associated radiocarbon dates
3) buried deposits with distinctive Clovis technology
4) dated sites without Classic Clovis artefacts
5) surface sites with Clovis technology

I adapted the data from both Bradley *et al.* (2010) and Miller *et al.* (2013), and formulated my own lists (Table. 2.1, 2.2, 2.4, 2.5). Most of the catagories that are listed above were

The date range for Clovis was equally debatable as the regional variation, with several attempts to refine the dates for Clovis being offered. In the 1970s the dating for Clovis was based on a few sites on the Great Plains (Blackwater Draw, Dent, Domebo, and Colby), where a date range of 11,500 - 11,000 ^{14}C yr BP was suggested (*e.g.* Haynes 1970, 1971, 1980a), Haynes refined these dates, and the modified date of 11,200 - 10,900 ^{14}C yr BP was put forward (*e.g.* Haynes 1992, 1993). Radiocarbon dates from the Aubrey site in Texas, suggested that Clovis was older on the Southern Plains, as the dates were 11,600 ^{14}C yr BP (Ferring 2001). A further refinement was put forward that suggested that Clovis was no more than 11,050 - 10,800 ^{14}C yr BP (Waters and Stafford 2007), based on accelerator mass spectrometry (AMS) dating on organics (*e.g.* seeds, bone, ivory) rejecting sites such as Aubrey (see Haynes *et al.* 2007). However, there are implications when interpreting the date range of Clovis when incorporating sites with no radiocarbon dates available (see Prasciunas and Surovell 2014). I adapted the data from several published sources (Hamilton and Buchanan 2007: Table. 1; Waters and Stafford 2007: Table. 1; Miller *et al.* 2013: Table. 12.2) when outlining the dates for my Clovis point sample.

When assessing the results of my basal concavity analysis on the sample of Clovis points, I am confident that the assemblages used in that analysis, fit the criteria for Clovis set out above (Miller *et al.* 2013). In Chapter 6 I will present my interpretations and conclusions of the regional variability of Clovis, and how this has implications that help our understanding of Clovis across the North American landscape.

Chapter 6

Conclusions: interpretations, discussion, and future research

6.1 Restating the research questions

In this study I set out to see whether lithic raw material variability, quality, and availability influenced Clovis fluted point shape and basal variability. To recap: here are my research questions that I set out to answer from Chapter 1:-

- what is the range of morphological variation in the bases of the points?
- is there a relationship between lithic raw material and the patterns seen in the basal technology?
- just how homogenous is Clovis?

After the literature review of the Clovis point archaeological record in Chapter 2, and the raw material analysis on Clovis point assemblages in my samples in Chapter 4, a few subsidiary questions arose that were also addressed:-

- how many Clovis point variants were identified, and where from?
- what were the regional movement patterns of the lithic raw materials?
- what was the distribution pattern of Clovis site types?
- how, if at all, did the analysis on the Clovis isolates help in answering the primary research questions?

In answering these primary and secondary questions I will take each region separately, as laid out in previous chapters. Initially I will restate my expectations of the region, and whether those expectations were fulfilled; if so showing how, and if not, why (Table. 6.1). I will look at how the lithic raw material evidence relates to regional and intra-regional movement, and also where Clovis site types are distributed and how the isolate and surface-collected occurrences contribute to Clovis presence in North America (Table. 5.8).

INITIAL EXPECTATIONS	OUTCOMES
NORTHEAST	
1. expected to find some variability within individual point assemblages, and some similarity with other assemblages within region 2. expected to build upon already recognised Clovis variants (Table. 2.3) 3. expected considerably more Clovis point variants than traditionally recognised Clovis point forms 4. expected high percentage local lithic raw material and localised movement within region, some intra-regional movement 5. expected high majority of Clovis sites to be campsites 6. expected very low percentage of isolated Clovis point finds	1. results supported my expectations, as some of the assemblages did show signs of variability. There were two significant groups of assemblages that had similarity within assemblages (Figure. 5.1) 2. within the most common Clovis point present, there were subtle variations in basal concavity shape 3. all assemblages in my analysis were a Clovis point variant I classified as deep-based Clovis fluted, plus a St. Louis Clovis fluted variant (Table. 5.3) 4. at least 50% of the assemblages have lithic raw material from non-local sources, multiple toolstone types present, but almost all regional. (Table. 4.2). Strong focus on intra-regional movement 5. almost the sites in the region are campsites, some with kill and butchery areas. These are mostly associated with caribou and deer interaction, seasonal re-occupation evidence 6. very few isolates from the region, however I did discover a few surface-collected isolates that are in my supplementary sample analysis (Appendix. A)
MIDDLE-ATLANTIC AND SOUTHEAST	
1. expected some variation within regional assemblages, with little variation in individual assemblages 2. expected both Clovis variants and traditional Clovis points in both subregions 3. expected raw material movement within Middle-Atlantic subregion and intra-site contact 4. expected split of campsites and quarry / workshops 5. expected more isolates in both subregions	1. the results from the analysis supported my expectations, although the size of individual site assemblages was low, less than three points 2. several Clovis variants present in both subregions (Table. 5.1), and the Clovis fluted points present across whole region 3. strong local pattern of toolstone exploitation within the Middle-Atlantic, some intra-site interaction 4. results show a mix of campsites and quarries in the Middle-Atlantic subregion, and campsites and workshops in the Southeast subregion 5. large percentage of surface-collected isolates across the whole region, especially the northeastern coastline, and southeastern river systems (Table. 5.1)
MIDCONTINENT AND GREAT LAKES	
1. expected similar variation within regional assemblages to that of the Northeast, some Clovis variants present 2. expected long-distance movement of toolstone into and out of the region 3. expected a much higher percentage of Clovis points due to mammoth / mastodon kill sites 4. expected more kill sites and kill / camps than other site types 5. uncertain of percentage of isolates, suspected it might be quite considerable	1. some Clovis variants present, although I classified one variant, the Gainey points, as being Clovis. However, several others were still present (Table. 5.1) 2. long-distance transport of toolstone more evident in western area of the region (Figure. 4.3), local use of certain lithic raw materials more evident in southeast (Table. 4.2), environmental barriers (Great Lakes) may have restricted shortest-distance movement 3. there were Clovis fluted points present, but whether associated with megafaunal kills is unclear 4. not as many kill sites as expected, more of a mix of site types, however some camps could be kill / camps, and some surface-collected points could have been associated with kills (Table. 5.1) 5. isolates present, especially in the Great Lakes area of region (Table. 5.1)
NORTHERN PLAINS	
1. expected majority of points to be traditional Clovis type, at least one variant present 2. expected intra-regional and long-distance movement of toolstone 3. expected wide range of site types, caches being present	1. large amount of Clovis fluted, and two variants were also present, deep-based rounded-eared variant, and the flat-based Clovis variant (Tables. 5.1, 5.5) 2. both local and long-distance transport, and evidence of long-distance import of toolstone

4. as with the Midcontinent and Great Lakes region, uncertain of frequency of isolates and surface-collected points	(Figure. 4.4; Table. 4.2) 3. combination of kill sites, kill / camps, and caches were present 4. some evidence of isolates and surface-collected points present across region (Table. 5.1)
SOUTHERN PLAINS AND DESERT SOUTHWEST	
1. expected majority of points to resemble the traditional Clovis form, very few variants 2. expected some isolate and surface-collected occurrences in the Desert Southwest subregion 3. expected intra-regional contact with the Northern Plains and within the two subregions. Some long-distance movement of toolstone 4. expected similar site type breakdown to that of the Northern Plains, apart from lack of Clovis point caches	1. results were mainly as expected, almost all Clovis fluted, and just one variant (Table. 5.1) 2. some isolates and surface-collected points were present, majority in Southern Plains subregion (Table. 5.3) 3. most common toolstone sources suggest widespread intra-regional dispersal, and movement on a non-local scale in and out of the whole region (Table. 4.2). 4. Southern Plains subregion displays different pattern to Desert Southwest which is more localised (Figure. 4. 5)
SOUTHWEST AND GREAT BASIN	
1. no expectations on point variability, but suspected a possible Clovis variant present 2. expected long-distance movement within region of toolstone 3. expected large percentage of toolstone to be regional varieties of obsidian 4. expected majority of points to come from surface-collected campsites 5. expected possible increase of isolated point occurrences	1. just Clovis fluted points present, although these points were previously termed 'Clovis-like' in previous studies, poor sample size (Table. 5.1) 2. clear long-distance movement of toolstone within region (Figure. 4.6) 3. use of obsidian dominant, local use, import from within region 4. majority of site types were campsites, surface-collected isolates appear in archaeological record 5. isolates not as common as expected (Table. 5.1), need a more extensive review
NORTHWEST	
1. expected some variability within region, but not within individual assemblages 2. expected majority of toolstone, if not all, to be local or regional varieties of obsidian 3. expected long-distance movement of toolstone, at least one example of extreme long-distance movement 4. expected a mix of cache and campsite site types 5. expected isolates to be quite well-represented	1. small sample of sites and point assemblages, mainly Clovis fluted, but two variants were present (Table. 5.1) 2. emphasis on local and long-distance transport of regional varieties of obsidian (Table. 4.2) 3. one case of extreme long-distance transport of toolstone (Figure. 4.7) 4. as expected the site types were caches and campsites 5. some surface-collected isolates were present (Table. 5.1), but as with Southwest and Great Basin region, not as many as expected, and might need a more thorough examination of the archaeological record

Table. 6.1 Expectations and outcomes taken from my literature review in Chapter 2, analysis and lithic raw material sourcing and movement patterns from Chapter 4, and results of the calipe- based metric and geometric morphometric (GM) and principal component analysis (PCA) tests in Chapter 5

There is considerable range in the shape of the basal sections of Clovis points over the whole of North America, but whether each of the basal variations should be attributed to a particular Clovis point variant is key. In this study, I originally had identified eleven separate Clovis point variants, including the traditionally-recognised Clovis fluted and unfluted forms (Table. 5.8).

After my analysis and the interpretation of the results, I re-classified these points down to five types:-

- Clovis fluted: well-recognised, and was termed ‘classic’ Clovis, and also ‘western Clovis’, a geographically confusing term, as it relates to the Midwest of North America
- Deep-based Clovis fluted: these points have been regionally termed ‘Debert’ and ‘Vail’ in the Northeast, and ‘Colby’ points in the Northern Plains
- Waisted Clovis fluted: these points were termed ‘southeast Clovis’, and although they do appear mainly in the Southeast region, I did identify some examples in other regions
- Flat-based Clovis fluted: these points were termed ‘Anzick’ points after they were discovered in the site’s cache in Montana
- Ross County Clovis fluted, and St. Louis Clovis fluted: I have kept these terms, as they are well-established in the literature, and although their technological characteristics are similar to the Clovis fluted form, there is enough basal concavity variation to suggest these points are a separate Clovis form
- Unfluted Clovis: I don’t believe there is enough research done on these points to suggest the unfluted are a separate and deliberate variant. It could be that these points are just examples of the Clovis fluted form that were not fluted, or that they were basally modified which removed evidence of the flute scars. I include the unfluted in this list, but I suspect it is an unfluted Clovis fluted type, and not a separate variant

With this new simplified classification of Clovis points, I believe any specimen can be attributed to a particular Clovis point form through its basal morphology, and with some degree of certainty which particular region it may have come from. This new interpretation, and my reclassifications (Table. 5.8), answers both my first research question and the first subsidiary question.

My second research question focused on raw materials and their influence on basal shape of Clovis points. I suggest there was no direct relationship.[23] Good quality, fine-grained toolstone would have been desirable, as it would be easier to work with, but not essential. My research shows that basal point shapes I identify are made from local and non-local toolstone. This answers the second research question.

In answering the third of my research questions, I can confidently put forward that within Clovis point basal concavity there is a lot of morphological variation over the entire North American continent: regionally, it could be more homogenous, in particular the Northeast and possibly Some of the Midcontinent and Great Lake assemblages. If one was to look at just Clovis fluted forms, I still would suggest there are morphological, typological, and technological differences in these points. These differences occur in both the blade section shape and size, and the basal concavity and basal ear style. Some of these points have convergent flaking to the mid-section, whereas others display almost *outré-passé* flaking, with large flake scars running across almost the whole width of the mid-section. When Clovis points are compared to other early Paleoindian points, such as Folsom, they certainly cannot be regarded as homogenous as those points.

In answering subsidiary question two, previous studies have included samples of Clovis points from specific regions (*e.g.* Holen 2001), and concluded that Clovis toolstone selection reflected long-distance migration. This is indeed the case in some regions, as I have shown above, but not in all the regions. These studies (see Tankersley 1989; Morrow 1996; Holen 2001; Sellet 2006; Ellis 2011; Waters *et al.* 2011a; Smallwood 2012) concentrated on a particular region (but see Miller *et al.* 2013; Buchanan *et al.* 2014), and Clovis groups did not undertake the same behaviour in every region. Clovis groups in the Northeast mainly kept to

[23] Clovis fluted points made from flakes could be regarded as being influenced by lithic raw material. Wernick (2015) suggests that although a small sample of Clovis points that were made on flake blanks does not reflect the typical point production, it is an indication that Clovis groups could have adapted their production strategies and sourced good quality toolstone over long distance movement

that region, perhaps following herds of caribou and deer on seasonal migrations. In the Southeast, the movement of Clovis groups may have been restricted, due to environmental boundaries, as were the groups that were in the Great Lakes area of the Midcontinent.

6.2 Interpretation of regional results

Below is a brief discussion of each region summing up the evidence gathered from the literature review in Chapter 2, the lithic raw material analysis in Chapter 4, and the metric, geometric morphometric analysis, and PCA tests in Chapter 5. These interpretations will help in my final analysis in answering the research questions above.

6.2.1 Region 1: Northeast

Through my literature review and the caliper-based metric analysis of the Clovis sites and the related point assemblages, I expected to find a lot of shape variation within the points. I did not expect to find much evidence for the traditional characteristic or ‘classic’ Clovis point, and most of the references refer to these points as 'Clovis-like' (*e.g.* Ellis 2004). Some researchers name these points after the site they were discovered, *e.g.* Bull Brook points, Vail points, and Debert points etc (Table. 2.3). In my findings I identified all the points as being deep-based Clovis and classified them as such (Table. 5.8). Although the vast majority of these assemblages were deep-based Clovis, there was one site that just had the Clovis fluted form, Shawnee-Minisink, in Pennsylvania. In addition, one isolate from Upper Cross Creek, Washington County, Pennsylvania (UCC 01), resembles the Clovis fluted form (Appendix. A). There was also a St. Louis Clovis point (VAL 24), recovered from the Vail site, in Maine (Table. 5.3). There were no Clovis isolates in any of my samples, and I did not register any during my literature review either (but see Lothrop *et al.* 2018). A brief look at the Paleoindian Database of the Americas (PIDBA) shows that only Pennsylvania has a fluted point survey available (Fogleman and Lantz 2006), and several Clovis points have been recorded here and placed in the PIDBA database for Pennsylvania (Anderson *et al.* 2010). One suggestion would be to encourage more research into the other areas of this region, and build upon this area of study (*e.g.* Anderson and Miller 2017).

The vast majority of sites in my analysis for this region were campsites, some with kill associations. The Vail site had two distinctive areas: kill site loci, and habitation areas. These areas were definitely contemporaneous, as many of the Clovis points are conjoined, and the separate fragments came from the two areas (Gramly 1984, 2004, 2009a). There is also the suggestion that the Lamb site, in Massachusetts could be a cache (Gramly 1999). This might go some way explaining the non-local lithic raw material in the assemblage (see Figure. 4.1; Table. 4.2). I expected a high percentage of local toolstone combined with localised movement within parts of the region. After my observations, it was evident there was a strong focus on intra-regional movement, and sites that had multiple regionally-sourced toolstone. And some of the sites were seasonally re-occupied, possibly interacting with and exploiting caribou and deer herds (Boisvert *et al.* 2017).

6.2.2 Region 2: Middle-Atlantic and Southeast

The two subregions will be discussed together in this section. There were several Clovis variants identified in both subregions. Through my literature review for the Middle-Atlantic, I established there were mainly Clovis fluted points and the waisted Clovis forms: this was also the case for my own analysis. There were also waisted Clovis and the St. Louis Clovis points that were identified from the Southeast subregion, although my sample size for the entire region was small. There are a lot more isolates in the Southeast subregion and this was also evident in my samples M and C (Table. 5.1); there is also an unfluted Clovis point from the Southeast subregion.

My expectations of this region before my analysis, was to suggest that there was some variation within regional assemblages, but little variation in individual site assemblages. This was particularly the case in the Southeast, where there were more Clovis assemblages from well-stratified contexts, *e.g.* Carson-Conn-Short site in Tennessee (Broster and Norton 1993), and two sites from Kentucky: the Adams site (Sanders 1988), and Big Bone Lick (Tankersley *et al.* 2009). In the Middle-Atlantic subregion, the Clovis sites are mainly quarries / camps, with some surface-collected assemblages. Whereas in the Southeast, there is a split between campsites, kill / camps, and workshops, which is what I had expected after my literature review of the available material. I had expected to see lithic raw material movement within the Middle-Atlantic subregion, and possibly some intra-regional movement from the quarries in Virginia to sites in the Northeast. This was not, however, the case, as there was only one site (Shoop in Pennsylvania) that had any toolstone from the subregion, which was Cattail Creek chert, a variety of Williamson chert. In fact the Williamson site had some Onondaga chert in the lithic assemblage, which outcrops in New York and was the primary toolstone of the Shoop site (Figures. 4.1, 4.2; Table. 4.2). In the Southeast subregion, there was a strong local pattern of toolstone exploitation, particularly in the Tennessee (*e.g.* Parish 2016) and Mississippi river systems (Morrow 2014a); the latter will be discussed in the relevant section below.

6.2.3 Region 3: Midcontinent and Great Lakes

I expected very similar variation within the regional Clovis point assemblages of this region to those from the Northeast, with some Clovis variants also present. There were more Clovis fluted than expected, especially in the kill site assemblages and isolates. The isolate occurrences were particularly high from around the Great Lakes area. These may have been surface-collected, and represent discarded points (see Eren and Desjardine 2014). The Clovis point forms that were present from this region include the Clovis fluted, St. Louis Clovis, and

Ross County Clovis points. The Gainey / Clovis fluted points, which were briefly discussed in Chapter 2, raise the issue of whether I should include the Gainey form as a separate type and call them Gainey Clovis. I chose to classify these points as Clovis fluted; I included a specimen in my C sample (GNY 01), and I am in agreement with recent interpretations on the current view of Gainey / Clovis point classification (see Eren and Desjardine 2014:117). The issue with Gainey and Clovis is a good example of where certain researchers attributed a point to a certain form, whilst others termed it as being Clovis [24].

The breakdown of Clovis sites in this region was not quite what I expected: I thought before my literature review and analysis of my samples, there would be mainly kill / camps. However this was not the case, and only one site was revealed to be a definite kill site with a Clovis association, that of Kimmswick, in Missouri (Table. 4.2). I believed there would be more kill sites in the region, due to the presence of extinct megafauna, such as mammoth and mastodon (see Agenbroad 1984; Fisher 1987). And for the same reasons given above, the expectation of Clovis fluted was put forward. This was indeed the case: a large percentage of the occurrences of these were isolates. The majority of sites in this region are campsites, with Clovis groups exploiting the seasonal resources (see Koldehoff and Loebel 2009). However, during the period when the glacial meltwater was feeding the Mississippi, there would have been environmental barriers that would have interfered with group movement (see Morrow 2014a). My interpretations after the lithic raw material review support this, as do the site and point distribution in this region (Figure. 4.3). There was a strong emphasis on very local toolstone use in the southeast of the region, whereas the western area has more distant toolstone, as well as exploiting certain types of local material (Table. 4.2).

[24] Bar-Yosef (2006) describes how English-speaking prehistorians in Africa rejected the term “Palaeolithic” for “Stone-Age” simply to distinguish themselves from their European colleagues.

6.2.4 Region 4: Northern Plains

In the Northern Plains I was expecting to see a large number of Clovis fluted assemblages, as well as at least one variant, the deep-based-rounded-eared Colby points from Wyoming, I also identified some of these point forms in the Fenn cache. As well as these variants, I also identified another variant in this region, the flat-based Clovis fluted points from the Anzick cache in Montana, specimen #'s 88.68.20 (ANZ 01), and 88.08.72 (ANZ 03). The presence of Clovis point caches contributed to a wide range of site types in this region, including kill sites, kill / camps and caches. There were, as expected, many isolate and surface-collected Clovis fluted points; interestingly, none of these were Clovis variants, but were all Clovis fluted (Table. 5.1).

In the lithic raw material analysis, I had expected both intra-regional and long-distance movement of the toolstone. In fact, there was both local and long-distance transport of toolstone, with some varieties of toolstone being found outside the region, as well as long-distance import of toolstone from outside the region (Figure. 4.4; Table. 4.2). The current understanding of Clovis mobility in the Northern Plains region, what the environment was like and how it changed during the Clovis era, as well as knowledge of lithic sourcing and procurement, has improved greatly in the last decade (see Holen 2014).

6.2.5 Region 5: Southern Plains and Desert Southwest

For the Southern Plains subregion I expected similar results to the Northern Plains. Insofar as the points were concerned, this was indeed the case, as nearly all were of the Clovis fluted form. There was just one specimen from McFaddin Beach in southeast Texas that was a waisted Clovis variant (Table. 5.1), which I identified from the literature review (Patterson 2000) and included in my S sample (Appendix. A). There was, however, also an unfluted Clovis point from Bull Creek in Oklahoma, spec # 34BV177-1 (BUL 01), that is in my M sample (Table. 5.1). During the literature review, I came across many references to surface-collected isolates, especially in Texas (Meltzer 1986a, 1986b; Meltzer and Bever 1995; Bever and Meltzer 2007). A few of these isolates, and others from Kansas and Oklahoma, are part of my analysis, and make the C sample (Table. 5.1). The site types are mainly kill sites and kill / camps, and there are no finished Clovis point caches in the subregion. There are, however, several Clovis blade and preform / point blank caches (see Bement 2014; Huckell and Kilby 2014b; Kilby 2014b). Some of the more well-known and documented caches from this subregion appear in my supplementary information section (Appendix. A). As expected, there was some intra-regional movement and contact with the Northern Plains. The major toolstone sources of Edwards chert and Texas Alibates show widespread intra-regional dispersal, and the movement of toolstone was on a non-local scale, with some instances of long-distance movement (Tables. 4.1, 4.2). There was a clear difference in the pattern within the two subregions, where the Desert Southwest movements and toolstone transport were more localised (Figure. 4.5; Table. 4.2).

One site assemblage that I included in my C sample was Eckles, from Kansas (Holen 2010). There were only two Clovis fluted points in my sample, so it was excluded from my GM / PCA test, but I did carry out a full caliper-based metric analysis. The interesting result from the Eckles assemblage is that although the points are both made from the same raw material, they demonstrate two different styles; the morphology of the larger point (ECK 01) is consistent with Clovis fluted from the east of Southern Plains, such as Kentucky and Tennessee, whereas the other specimen (ECK 02) is more similar in style to other Clovis fluted points from the Northern and Southern Plains. It is speculated that an individual may have joined the Clovis group from the east, and travelled west to the source of the toolstone (Flattop Butte chalcedony), and produced a point in the style he/she was accustomed to, before returning with the group to northern Kansas (Holen 2010).

The Clovis point types from the Desert Southwest were as expected, mainly Clovis fluted forms: there was just one example of an unfluted Clovis from Bigbee, New Mexico (BGB 01), which was part of my C sample (Table. 5.1). The breakdown of Clovis site types in the subregion was also as expected. The majority were kill sites and kill / camps. Two of the largest and well-documented kill / camps are from this subregion: Blackwater Draw in New Mexico, and Murray Springs in Arizona. The Murray Springs site had both butchery and processing areas, as well as a separate habitation area, which were contemporaneous. Evidence for this comes from the conjoined fragments of Clovis fluted points coming from both areas, similar to the Vail site in the Northeast. The Murray Springs site is part of the San Pedro Valley system of sites and point occurrences that were associated with mammoth kills (Haury 1986). As well as the well-documented sites of Lehner, Naco, and Escapule, there are several surface-collected isolates and archaeologically-recovered isolates from this area that also could be related to the mammoth kill (Table. 5.1). Some of these are discussed further in the supplementary information (Appendix. A).

6.2.6 Region 6: Southwest and Great Basin

The small size of the sample I had for this region reflected the lack of sites and Clovis-aged point assemblages in the archaeological record, and was an accurate representation of Clovis points in the region. The literature review revealed that the majority of point occurrences in the region are isolates that were surface-collected (Beck and Jones 1997). The one assemblage from an archaeological context that I did have access to was the Borax Lake site on the north coast of California (Table. 5.1). These points are Clovis fluted, and are all basal sections. This gives the suggestion that the Borax Lake site was a campsite or base camp, where fluted point maintenance was carried out. My initial expectations for this region was to find a Clovis variant, mainly due to the fact that these points were originally classified as being Folsom-like (Harrington 1948). They have since been attributed to Clovis (Clark

1964), but were still referred to by some as being 'Clovis-like' (*e.g.* Haynes 2002:72; but see Erlandson and Moss 1996:283). I dropped this term, and classified them as Clovis fluted, as the basal section characteristics reveal very little difference from the Clovis fluted form, and the flaking technology resembles that of Clovis as well.

I expected the site type, what few there were, to be campsites. Apart from the Borax Lake campsite, there are a few more campsites in the archaeological record, one of these, China Lake, is in my S sample (Table. 5.1; Appendix. A). Most of the other Clovis point occurrences were from surface-collected isolates, but there are still not that many. A Utah fluted point survey (Copeland and Fike 1988) documented only eighteen known Clovis points from the state. Some of these are recorded in the supplementary information section (Appendix. A). Similar results came from the survey of Great Basin fluted points and from Nevada as discussed above in Chapter 2.

One specimen that I identified during my data collection is in my C sample, which is from a military training facility in Utah (DMG 01). This point is a Clovis fluted form, and like the points from the Borax Lake and China Lake assemblages, is made on a variety of obsidian. Use of obsidian in this region is dominant, although one of the points from the Borax Lake assemblage (BXL 01) is made on San Franciscan Bay chert (Table. 4.2). As expected there was long-distance movement of toolstone within the region (Figure. 4.6).

6.2.7 Region 7: Northwest

The final region to be summarised here is the Northwest, and I expected similar results in the types of Clovis point present. However, as there were several caches from the region, I did initially expect there might be some variability within the region, but not within individual assemblages. Both the Simon cache from Idaho, and the East Wenatchee cache from Washington, had very distinctive points, but showed little variation within their own assemblages. The Fenn cache would be the exception, if we were to include it in this region, as it was reported to have been discovered somewhere along the Utah, Wyoming, and Idaho border [25] (Frison and Bradley 1999). Although a small sample size of Clovis archaeological sites was expected, there was an even split between campsites and caches (Table. 5.1).

From the literature review I expected there would be considerably more Clovis isolates and surface-collected occurrences than archaeologically-stratified Clovis sites, which was the case (Table. 5.1). There was an emphasis on local and long-distance transport of obsidian, *e.g.* the Clovis fluted point recovered from the Blackwater Draw site in New Mexico (Figure. 4.7; Table. 4.2). This breakdown of toolstone was as expected, where the majority of raw material, if not all, was either sourced locally or regionally local, from varieties of obsidian.

6.3 Discussion: Clovis points, people, and places

Geographically, Clovis is the most extensive of any early occupation in the North American archaeological record. The diversity of the mobility and adaptability of Clovis groups is remarkable. Their understanding of diverse environmental conditions and the rate and direction of changes in the environment, required a high level of adaptability. This aspect of Clovis is well-documented (see Haynes 1964; Kelly and Todd 1988; Haynes 2002; Meltzer 1985, 1988, 2003, 2004, 2009, Ellis 2011, Holiday and Miller 2013; Miller *et al.* 2013; Amick 2017). A general view of the landscape across the continent, will help understand the types of Clovis site and their distribution, and the nature of the local resources that might attract the Clovis hunter-gatherer groups.

[25] Although it has been suggested to have come from Sweetwater County in Wyoming (Lassen 2005). But this provenance has yet to be verified and for purposes of this study the exact location will remain unknown, In most cases I will attribute Fenn to Wyoming, unless other wise stated. Sweetwater County does border Utah and Idaho and several Clovis sites and Clovis isolates are reported from the county (see Prasciunas *et al.* 2008)

6.3.1 Discussion Pt. 1: Clovis in the North American landscape

Clovis groups in North America would have had to deal with a landscape and a climate unlike any later groups. Sea levels were lower, but steadily rising, and the Cordilleran (western) and Laurentide (eastern) ice sheets were still widespread. The whole continent was experiencing rapid environmental change from the late Pleistocene and the Last Glacial Maximum (LGM) to the post-glacial conditions of the early Holocene [26]. There are few overviews of the late Pleistocene environment that deal explicitly in this time range: most reviews on the late Pleistocene concentrate on the conditions during the LGM (*e.g.* Porter 1988; Orme 2002), broader reviews and reconstructions (*e.g.* Porter 1983; Ruddiman and Wright 1987; Wright *et al.* 1983; Dyke *et al.* 2002; Gillespie *et al.* 2004), or reports of specific site data.

The southern extent of the glaciers from the Great Lakes going further east into the New England states, during the late LGM and early YDC was cool and dry, although there were slightly wetter conditions in some local areas (see Ellis *et al.* 2011); in the Midcontinent, conditions were warmer and wetter in the late LGM (see Grimm and Jacobson 2004). In the Northeast, especially in the maritime areas, significantly cooler and likely wetter conditions following the late LGM were occurring (see Lothrop *et al.* 2011). In the Middle-Atlantic and Southeast during the late Pleistocene, conditions were cool to temperate along the eastern coastline from the south-central Atlantic coast, down to the eastern Gulf coast (see Delcourt and Delcourt 1981; Williams *et al.* 2004). However, along the Florida peninsula, conditions changed from cool to warm, and from dry to wet (*e.g.* Grimm and Jacobson 2004; Williams *et al.* 2004). Cooler conditions prevailed in the Northern Plains region during the late LGM up until ~ 12,000 Cal yr BP (in the middle YDC), followed by a warmer shift in conditions

[26] The late glacial refers to the recessional phase of the Last Glacial Maximum, ~ 19,150 to 12,900 Cal yr BP / ~ 16,000 to 11,000 ^{14}C yr BP, based on beginning of substantial retreat of the Laurentide ice sheet and the beginning of the Younger Dryas Chronozone (YDC), ~ 12,900 to 11,500 Cal yr BP. The Pleistocene / Holocene boundary is at the end of YDC. The age range for Clovis being ~ 13,400 to 12,700 Cal yr BP.

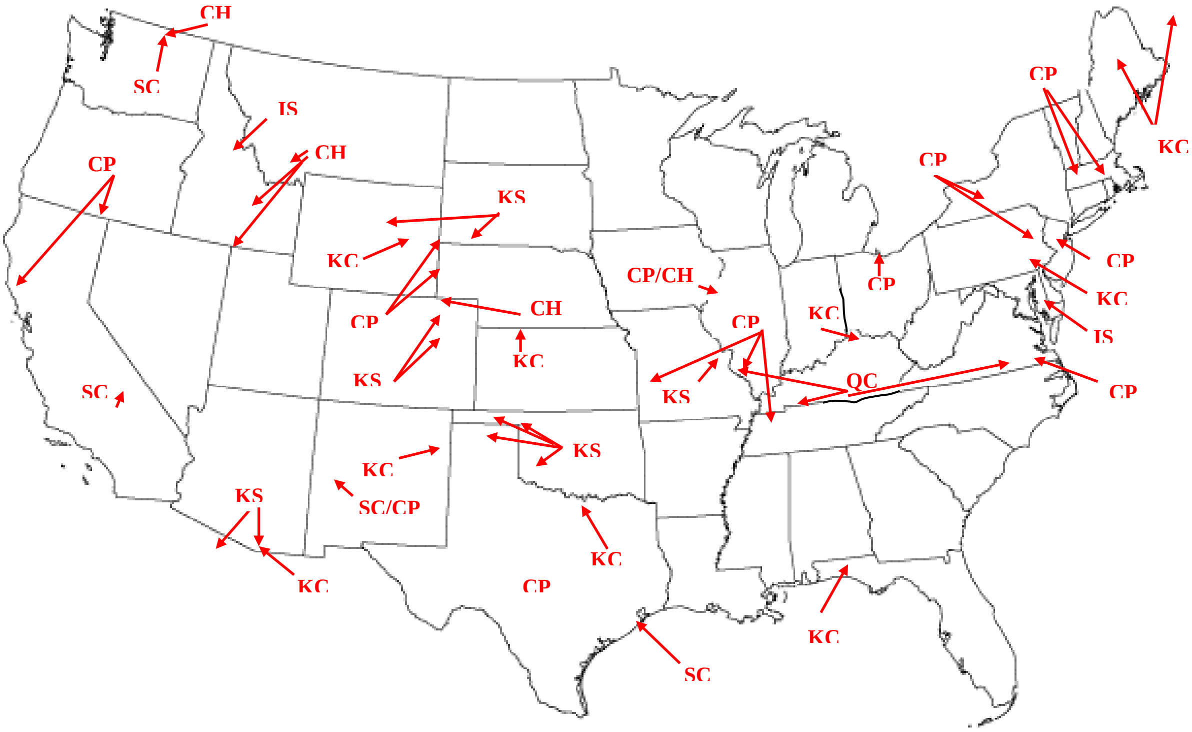
(see Grimm 2001; Yansa 2006; Nordt *et al.* 2008). Throughout most of the Southern Plains subregion, the late LGM was a period of declining moisture, and continued to dry through the YDC up until the Holocene (see Johnson and Willey 2000; Feggestad *et al.* 2004; Miao *et al.* 2007; Cordova *et al.* 2011). In the Desert Southwest subregion, at some point during the YDC, the sustained wetter weather declined, and a distinct shift towards warmer and drier conditions existed (see Holliday 1995, 2000a). There are very limited data from New Mexico and the San Pedro Valley sites in Arizona (but see Haynes 1991; Haynes and Huckell 2007; Ballenger *et al.* 2011). Temperatures varied in the Southwest through the late Pleistocene, especially along the west coast (see Reeder *et al.* 2011). The environmental changes at the time were said to be *"not very dramatic"* (Reeder *et al.* 2011: 465), and the rainfall changes were difficult to test. Reeder *et al.* (2011:47) suggest further *"climate change was evidently insufficiently intense or sustained to have widespread ecological impact in the region"*. In the Great Basin area of the region, considerable paleoenvironmental work on the late Pleistocene deposits has suggested it was a wet and cool climate (see Goebel *et al.* 2011; Grayson 2011). Paleoenvironmental records from the Northwest region indicate warming by the late Pleistocene (see Barnosky *et al.* 1987). This region has for decades been the subject of archaeological theory proposing widespread coastal adaptations and maritime lifeways (*e.g.* Davis *et al.* 2002), and earlier coastal settlement, aquatic resources, and maritime migrations (see Erlandson 2001; Bailey 2004; Erlandson and Fitzpatrick 2006; Erlandson *et al.* 2008).

Regionally, the environmental effects of the YDC differed across North America (*e.g.* Broecker *et al.* 2010; Meltzer and Holliday 2010), and the regional variations may have contributed to the regional variability within the Clovis assemblages. Clovis originated during a warm climatic phase (Haynes 2002; Haynes 2005; Stanford *et al.* 2006). During the shift to colder and drier conditions. Clovis groups were migrating into deglaciated areas of the Northeast region and margins of the Great Lakes. They developed into being specialised hunters of caribou and red deer. Towards the west there was a decline in the mammal populations (see Cannon 2004), which may reflect on the richness, or rather the lack, of Clovis sites and point assemblages in the Southwest and Northwest regions. The highest population densities and greatest variation in Clovis were suggested to be in the Southeast, lending support for the area where the spread of Clovis across North America occurred, despite where the origins of Clovis are (*e.g.* Mason 1962; Lepper 1999; Anderson and Faught 2000; Anderson *et al.* 2008, 2015; Faught 2008; Beck and Jones 2010, 2012, 2013, 2015; Eren *et al.* 2016). Some researchers suggest the spread of Clovis populations from the southeastern North America was driven by rising sea levels (*e.g.* Anderson 2001, 2012; Anderson and Bissett 2015; Smallwood *et al.* 2015), whilst others suggest the expansion was caused by the pressures of a growing population in the region and the decreasing numbers of local game resources (*e.g.* Kelly and Todd 1988; Dincauze 1993b; Spiess *et al.* 1998; Barton *et al.* 2004). The diversity within regional subsistence patterns, lithic raw material sourcing and exploitation, as well as the morphological variation within Clovis point assemblages, suggest some of the Clovis groups eventually settled and developed regionally isolated populations and had local adaptations (the Northeast region being an example of this).

Early views of Clovis subsistence economics were influenced by the discovery of kill sites and the archaeological observations of large extinct mammal bones (Meltzer 1993): that historical view of Clovis led to the suggestion that Clovis groups were specialised big-game hunters (*e.g.* Mason 1962; Martin 1972; Kelly and Todd 1988, but also see Surovell and Grund 2012), whilst more recently Clovis subsistence is increasingly considered more generalised (*e.g.* Stanford 1991; Grayson and Meltzer 2002, 2003; Cannon and Meltzer 2004; Meltzer 2004). Most of the species of North American megafauna were in decline during the late Pleistocene. Climatic stress, floral reorganisation, and human intervention were contributing factors, but evidence suggests that many species coexisted with Clovis, and later groups, for a considerable time after (Surovell and Grund 2012).

The traditional understanding of Clovis groups in North America was that their lithic procurement implied long-distance mobility: many Clovis point assemblages contained toolstone from >500 km away (see Sellet 2006; Huckell *et al.* 2008; Holen 2010). More recently, research in the Great Lakes area has shown that Clovis groups were capable and prepared to transport large amounts of toolstone great distance (*e.g.* Boulanger *et al.* 2015). In the Northern and Southern Plains region, Clovis points made from good to high quality lithic raw material were being transported and cached on regional and intra-regional scale. There is good evidence that Clovis groups in the Northwest, and Southwest were transporting local and non-local varieties of obsidian long distance, and extreme long distances. These interpretations on lithic sourcing and procurement helped to answer another of the second of my subsidiary research questions: what were the regional patterns of lithic raw materials, and what was my interpretation of these patterns? The basal point shape analysis has helped in my interpretations of the regional distribution of certain basal shapes within the Clovis point assemblages.

It is evident in the breakdown of Clovis sites and functions taking place at these sites, that there is a wide-range of activities taking place, both hunting and butchery, as well as more domestic activities. The distinction is not a regional one, and these activities are carried out across North America. This is far more evident in the Northeast, but that is due to the region having a more complete archaeological record, the most significant distinction between the Northeast and other regions is the game being exploited: caribou and red deer. There are sites in other regions that are carrying out the same activities in separate activity areas at the same site. Evidence for this comes from the re-fitting of lithics at the site.



Clovis site types

CP campsite
KC kill / camp
QC quarry / camp
WK workshop
KS kill site
CH cache
SC surface-collected (multiple finds, possibly location of
    buried stratified site
IS isolates

Figure. 6.1 Map of North America showing the distribution of selected Clovis site types, based on site assemblages used in my analysis (see Figures. 3.2, 3.4; Tables. 3.1, 3.3)

Across the continent the most common Clovis site type were campsites (Table. 2.4). The campsites can be split into two sub-groups: base camps, and processing-camps, as discussed in Chapter 2. Base camps were present in every region in my study, most prolific in the Northeast followed by the Midcontinent and Great Lakes regions (Figure. 6.1). Again, this may have a lot to do with the interaction with caribou and deer herds that were also present in the Great Lakes area (O'Shea *et al.* 2013). Kill sites: I included mammoth, mastodon, gomphothere, and bison kills in this study, but they are absent from the Middle-Atlantic and Southeast subregions, Southwest and Great Basin, and Northwest regions. Kill / camps: sites that have evidence of kills, butchery, and habitation, follow similar patterns to those of kill sites (Figure. 6.1). Clovis quarries and workshops do not seem to be present in the Northern Plains, which was surprising considering the quality of toolstone that came from the region (but see Park 2010) [27]. The main quarries that appear in my study are located in the Middle-Atlantic and Southeast region, with workshops in the Southeast subregion, Desert Southwest subregion, Northeast and Midcontinent and Great Lakes regions (Figure. 6.1).

The last site type to be discussed here are Clovis caches. The caches I included in my study are finished point caches. These appear in every region apart from the Middle-Atlantic and Southeast, and Southwest and Great Basin regions, where they remain conspicuously absent. It has been suggested that the distributions of lithic raw material resources may have sufficient enough for the groups in these regions at that time, for caching not to be necessary (Kilby 2008). Although others suggest that all Clovis caches are examples of materials that were not retrieved (Buchanan *et al.* 2012), there is also the suggestion of ritual and symbolism (Kilby and Huckell 2013). What is certain is that Clovis caches demonstrate an extensive knowledge of their landscape, provisioning lithic raw material resources, and use of repeated efficient routes of travel (Bamforth 2014). My observations on the toolstone in Chapter 4, and my results in Chapter 5, support this view and helps answer my third subsidiary research question.

Leading on from Clovis site type, my fourth subsidiary question focused on the contribution of isolate point finds. Although strictly not a site type, Clovis isolates and surface-collected isolates, are also abundant over the entire continent. Clovis point isolates

[27] Two Clovis fluted isolate points from Montana were found in separate locations, both made on obsidian, that has been sourced to an obsidian quarry in Yellowstone Park (Park 2010)

are present in the archaeological record from all but the Northeast region, and that might be down to oversights in my literature review. Surface-collected Clovis points are however present in every region (Tables. 2.4; 5.1). These Clovis point isolates proved to be a valuable source of information in this study. Whilst they did not make up the GM / PCA tests, a large quantity of them (Tables. 3.2; 5.1) were included in my caliper-based metric analysis (Appendix. C).

6.3.2 Discussion Pt. 2: Clovis a human behavioural perspective

Although specialised big-game hunting was not the primary component of Clovis subsistence, the question of how Clovis groups moved so far, so quickly still remains (Meltzer 2003a). Some researchers associate the fast dispersal to the changing climates and environments of the late Pleistocene in North America (*e.g.* Kelly and Todd 1988; Kelly 1996, 1999; Fiedel 2000). Clovis groups had to move quickly and over long distances, as the populations of megafauna were in decline. I am in agreement with Meltzer (2003a:552) who "attributed the rapid and widespread movement of Clovis groups in part to their unfamiliarity with the landscape" (see also Meltzer 2002, 2003b, 2004). These groups were colonising a diverse and totally unfamiliar landscape in a new continent (Slade in press b). Landscape learning has several elements whereby Clovis groups were able adapt to a new environment: information systems, weather tracking, and resource mapping (Meltzer 2003b). When human populations were low, these groups were at their most vulnerable to extinction (see Moore 2001): under these circumstances, survival may well have favoured a rapid extensive exploration of the landscape in order to provide the hunter-gatherer groups with the knowledge in an unfamiliar environment.

The concerns associated with a rapid long-distance movement of peoples are that on a continent the size of North America, populations would have been thinly stretched across the landscape (see Malhi *et al.* 2002). In avoiding inbreeding groups would have to keep up a healthy population and an accessible source of potential mates (Surovell 2000). This could be achieved in frequenting known and frequently-visited intra-regional campsites outside their own respective region: sites such as Blackwater Draw, New Mexico, and Murray Springs, Arizona.

Ultimately it was a fine-balance for these Clovis groups who were competing with several demands (Meltzer 2002): between procuring enough resources, whilst the preferred resources were in decline, to learn as much as possible about an unfamiliar landscape and its resources as quickly as possible, and to maintain the groups' healthy gene pool. Adopting this model and the large-scale exploration needed to map the North American landscape, caches may provide the archaeological signature: lithic tool and raw material caches are indeed present in Clovis times, but not in later Paleoindian times. A high settlement mobility to maintain contact with other groups, and to monitor resources and environmental conditions beyond their regional and social boundaries, would be crucial in meeting these criteria.

This model has not been fully put to the test, largely due to insufficient data being available (Meltzer 2003a:553), but it is one that is supported by the interpretation of my results, and through my observations of Clovis.

6.4 Directions for future research

Several areas of North America were significantly underrepresented by stratified archaeologically-recovered assemblages: the Southeast subregion, and the Southwest and Northwest regions in particular. Some of the regions included areas that had no, or very few Clovis fluted points that appeared in my main sample analysis (Tables. 5.8, 6.1). These areas may well have Clovis point occurrences that I had no access too at the time, and a more extensive literature review may reveal these. Some assemblages that have been reported which include Clovis points, that come from these underrepresented areas, could have their artefacts made more accessible, and perhaps have good quality epoxy resin replicas made of the points, to enable access for future research and analysis. The call for information by the authors of the PIDBA database is definitely a step in the right direction (Anderson and Miller 2017).

A subject for future research for this author would be to increase my sample size from existing Clovis point assemblages from collections in other museums and institutions that I did not visit. Private collections of Clovis points that might allow access for a metric and digital photographic record which would allow further tests of my methodology and hypothesis further. I hope to build on my own collection of good quality epoxy resin Clovis point casts (Appendix. C), which will be made available for study for students and researchers here in the U.K. (Slade 2018).

6.5 Concluding comments

Comparisons to the prehistory of the late Pleistocene and early Holocene northern of North America and that of northern Europe is an interesting concept. There are some comparisons: in timing, in climate, in landscape, in flora and fauna, and in new occupants (Price 1991). The occupation of both continents occurs just after the ice sheets begin to retreat. Tundra and forests are the dominant vegetation, and large mammals such as mammoth, mastodon, and caribou and red deer are common in both. The end of the Pleistocene also saw the two last colonisations of the earth's landscapes by *Homo sapiens:* that of greater Australia, pushed back now to ~ 65 ka, and the Americas (Beaton 1991). Beaton (1991:215) puts forward two forms of colonisation: *'Estate Settlers'* and *'Transient Explorers'*. I suggest that the idea of estate settlers could attributed to later Paleoindian groups, such as Folsom, but Clovis would likely be more associated with the transient explorer model; if we are to refer to Beaton.

Occupation of North America by Clovis peoples was most likely achieved through a combination of factors. The idea of Clovis being the result of cultural dispersal and demographic expansion has been well-documented (see Young and Bonnichsen 1984, 1985; Collins *et al.* 2013), and it was the demographic spread of Clovis that some researchers suggest played the greatest role in the colonisation (Stork 1988). Stork argues that "C*lovis' demographic expansion into the deglaciated Great Lakes region was based on strong social desires to maintain cultural identity among Clovis populations documented by shared similarities in lithic material selection and use"* (Storck 1988, 1991). Concentration of Clovis locations often reflect patches of concentrated resources: food, wood, lithic raw materials, water sources, etc (Beaton 1991), and may have included refugia for dwindling populations of megafauna (Haynes 2002, 2013). Gaps in the Clovis landscape, suggesting avoidance of certain areas, include low floodplains, remote mountainous areas, featureless plains, and subglacial regions, although future intense regional research may address this issue and indicate whether it is geologic or sampling biases that explain the sparse data (*e.g.* Loebel 2012).

As noted by Gamble (1982:92), *"all material culture has the potential to carry information...{and objects} are seen as part of a system through which communications was achieved by adherence to a set of stylistic rules."* In the case of Clovis, it may be fortunate that lithic artefacts, and for the purposes of this study the fluted points, which are the most durable of all materials and capable of revealing considerable information, such as the amount of decision-making and production sequencing, seem to have played a considerable role in the communication of information within Clovis social relationships and behaviour.

Appendices

Appendix. A

Supporting information: regional association of Clovis-aged sites in North America

A.1 Introduction

In this appendix I include a range of early Paleoindian sites and point assemblages that have a Clovis association that did not appear in the main thesis. During my literature review I came across many well-documented sites, some less so, that for different reasons were not directly relevant to my analysis, or failed the site / point selection process laid out in Chapter 3. Some of the reasons for omission were:-

- site or point assemblage clearly pre-Clovis or post-Clovis
- was not able to get direct access to material
- Clovis lithic assemblage did not contain any points, including blade and toolstone caches
- sites or point assemblages were well beyond my geographical area of study
- some of the Clovis point assemblages were brought to my attention after my data collection

This part of my study follows the same format as my Clovis regional overview initially set out in Chapter 2, where I have broken down the North American continent into separate regions based on previous research and modern political boundaries (Figure. 1.1). I will present the data here in a series of seven regional tables (Tables. A.1 to A.7). They will include possible pre-Clovis, and post-Clovis, as well as Clovis-aged sites and assemblages.

This is by far a long way from being a complete and exhaustive overview of all the Clovis sites in North America, but it was at the time of writing in 2018, a comprehensive review of the Clovis fluted points sites that I did cover in my analysis; Clovis sites that had lithic assemblages but no points; Clovis sites that had no lithics at all; and possible Clovis sites that for one reason or another had issues with their direct affiliation.

A.2 Regional association of Clovis-aged sites and assemblages

The patterns within the distribution of Clovis site types mirror those discussed in the main thesis. In the Northeast there more campsites than any other site type, and although there might be the odd example, there are very few isolates. The point types are following the same trends as my analysis suggested, with deep-based Clovis variants being more popular than other variants, including Clovis. In all the regions, the same picture is repeated in site type distribution, Clovis point type distribution, isolate and surface-collected findspots, and toolstone sourcing and transport. The cache evidence in the Southern Plains is of great interest, Occurrences of a great many blade and biface caches are present in this region, as opposed to finished point caches found elsewhere (*e.g.* Green 1963; Condon et al. 2014)

In the Northern Plains region, in eastern Colorado, there were Clovis points recovered from several gravel pit sites and isolate surface-collected Clovis points from the Kersey Terrace and South Platte River area (see Holliday 1987; Zier *et al.* 1993; Jepson *et al.* 1994). And from the Kersey and Kuner river gravels near Greeley (Haynes *et al.* 1998). Clovis fluted points have been found throughout Nebraska but are nowhere near as numerous as later Paleoindian point types such as Cody in the west or Dalton in the east of the state (Holen 1995). Across the whole region numerous occurrences of isolate Clovis points and surface finds have been reported and are well-documented in the Paleoindian Database of the Americas (PIDBA) and their call for data (Anderson *et al.* 2010; Anderson and Miller 2017).

Several isolated Clovis points have been reported in the Southwest Region area of the Colorado Plateau, Utah (see Copeland and Fike 1988). Clovis points do occur in Nevada, but none have ever been found in a well-stratified, well-dated context, and none in association with extinct megafauna. A number of isolated surface finds have been found in Nevada but even these are extremely rare. Two Clovis points have been found in Elko County, northeast

Nevada, an area the size of Massachusetts, Connecticut, and Rhode Island combined, despite intensive archaeological survey (Hockett *et al*. 2008). Clovis activity has been reported at in Nye County in western Nevada at Lake Tonopah, and two other locations (Haynes 1996). A relatively late date of 10,350 ^{14}C yr BP on a mammoth ivory point and a barbed antler point from northwestern Nevada (Rendall 1966) may indicate a late survival of mammoth in a region lacking extensive Clovis activity.

In the Northwest, Clovis fluted point occurrences in Oregon are mainly represented by isolates and surface-collected (see Rondeau 2003, 2004, 2005, 2006a, 2006b, 2009b; Rondeau and Dougherty 2009, and see Rondeau 2014). Recent studies in fluted point occurrences from the far west include over one hundred and fifty (42% of the total sample) from California. Bar far the most common are basal sections. As the basal sections are the primary characteristic of the points in my study, this could be a resource for future research. The CalFluted research reports are all available on request from the Rondeau Archaeological project, and are an important resource, not just in California but for Oregon and Nevada also (*e.g.* Rondeau 2006c, 2008, 2009a, 2009c). Clovis stratified archaeological occurrences in Idaho are rare, although there are a number of isolated fluted points and basal fragments from Clovis points reported in a fluted point survey carried out in southeastern Idaho (Titmus and Woods 1991). Two Clovis points from Seagull Bay (10PR89) were recovered, one of which (SGB 01) makes up part of my sample of isolates (Appendix C). Both points are made on obsidian that has been sourced to Big Southern Butte, Idaho (Reid *at al.* 2014). A recent review of Clovis in Idaho recorded isolated Clovis fluted point occurrences and possible Clovis sites (Read *et al.* 2015).

Table. A.1 Northeast region

SITE / ASSEMBLAGE	SITE TYPE	CLOVIS ASSOCIATION	COMMENTS	PRIMARY SOURCE
Arc site,, Genesee County, NY	Camp	Fluted points that resemble Clovis, and other lithics	Clovis / Gainey connection. Site dated to 10,370 ± 108 ^{14}C yr BP that post-dates Clovis	Tankersley *et al.* (1997) Eren *et al.* (2011)
Bowser Road Mastodon, Orange County, NY	Kill	Clovis lithics, bone and ivory artefacts, no fluted points	Discovered in 2013, there is vidence for mastodon butchery of Clovis-age - 11,031 ± 54 ^{14}C yr BP / 13,000 Cal yr BP	Gramly (2017)
Corditaipe, Omeida County, NY	Camp	Fluted points that resemble Clovis, and other lithics	A possible late Clovis or post-Clovis component	Funk and Wellman (1984)
Dutchess Quarry Caves, Orange County, NY	Kill / Camp - cave system with occupation	Fluted points and other lithics - attributed to the Clovis / Cumberland Tradition [1]	Caribou bones in direct association with fluted points and other lithics, excavated in the 1960s and has a date from caribou bones of 12,530 ± 370 ^{14}C yr BP which gives it a pre-Clovis age	Funk *et al.* (1969a) MacDonald (1971) Wormington (1971) Funk and Steadman (1994)
Hedden, York County, ME	Camp	Lithics resembling Clovis	A probable late Clovis component	Spiess and Mosher (1994)
Hiscock, Genesee County, NY	Kill / Camp	Fluted points that resemble Clovis, and other lithics	A possible late Clovis component	Laub (2003)
Kings Road, Greene County, NY	Camp	Fluted points that resemble Clovis, and other lithics	A probable post-Clovis component	Funk *et al.* (1969b)
Meadowcroft Rockshelter, Washington County, PA	Camp	Unfluted pre-Clovis point, and other lithics	Long-time controversial pre-Clovis site	Adovasio (1983)
Potter, (27CO60), Coos County, NH	Camp	Fluted points that resemble Clovis, and other lithics	Multicomponent site with Clovis association. The Clovis points resembling Bull Brook	Rockwell (2016) Boisvert *et al.* (2018)
Reagan, Franklin County, VT	Camp	Fluted points that resemble Clovis, and other lithics	A possible late Clovis or post-Clovis component	Ritchie (1953)
Sugarloaf, Franklin County, MA	Camp	Clovis fluted points and other lithics	A cluster of single component, Clovis encampments	Gramly (1998, 2014)
Templeton, (6LF21), Litchfield County, CT	Camp	Fluted miniature points, and other lithics	Deeply buried stratified Clovis single-occupation site, represents the oldest occupation in Connecticut	Moeller (1980)
Turners Falls, (19FR324), Franklin County, MA	Camp	Fluted points that resemble Clovis, and other lithics	Clovis / Gainey connection	Binzen (2005)
Upper Cross Creek, Washington County, PA	Isolate / Surface-collected	Clovis fluted point [2]	Pristine condition, and is said to have not had any resharpening. Believed to be made on Bellefonte chalcedony - 200 km away	Gramly (2011)

Wapanucket No. 8 Site, Plymouth County, MA	Camp	Clovis points and other lithics	Multicomponent site with Clovis association	Robbins and Agogino (1964)
West Athens Hill, Greene County, NY	Quarry / Camp	Fluted points that resemble Clovis	A possible late Clovis or post-Clovis component	Funk and Johnson (1964)
Whipple, Cheshire County, NH	Camp	Clovis fluted points and other lithics	A full lithic toolkit, including preforms that resemble Clovis, but no finished points	Curran (1984)

[1] Gramly suggests (2009) that Cumberland pre-dates Clovis, and points out that Wormington segregated Clovis from Cumberland in her 2nd (1944) and 3rd (1949) editions of her Ancient Man in North America publications, terming them Ohio fluted. Most other researchers would coll these Clovis (see also Boldurian and McKeel 2011)
[2] Other isolated Clovis fluted points have been found in this area and have been previously reported (see Lowery et al. 2007), and have been reported in elsewhere in Pennsylvania (Fogelman and Lantz 2006)

Table. A.1 Early Paleoindian sites that have Clovis association that do not appear in main body of the thesis, but the sites in bold do appear in my comparative C sample 2), and supplementary S sample). (see Tables. 3.2, 3.3; 5.1)

Some of the sites in the Northeast region that are listed above represent some of the earliest occupation in the region, although they are said to post-date Clovis. The sites and the lithic assemblages, including the fluted points, are reviewed and discussed elsewhere in more detail (see Chapdelaine 2012; Gingerich 2013a, 2018)

Table. A.2 Middle-Atlantic and Southeast region

SITE / LOCALE	SITE TYPE	CLOVIS ASSOCIATION	COMMENTS	PRIMARY SOURCE
Middle-Atlantic Subregion:				
Cactus Hill, (44SX202), Sussex County, VA	Camp	Pre-Clovis unfluted point component, as well as Clovis fluted point and other lithics	Large gap in-between the occupations:- Pre-Clovis 15,070 ± 70 ^{14}C yr BP Clovis 10,920 ± 250 ^{14}C yr BP	McAvoy and McAvoy (1997) Wagner and McAvoy (2004)
Elliot's Island, (18DO440), Dorchester County, MD	Camp / Surface	Clovis points and a Clovis variant [1] other lithics	Clovis artefacts found along eroding shorelines	Lowery *et al.* (2011)
Fifty, and Fifty Bog sites, Warren County, VA	Camp	Clovis points, and other lithics	Large processing areas, part of the Flint Run Paleoindian Complex, along with Thunderbird	Carr (1974) Carr *et al.* (2013b)
Meekins Neck, (18DO70), Dorchester County, MD	Camp / Surface-collected	Clovis points and other lithics	Large multicomponent, including Clovis with three separate clusters	Lowery and Phillips (1994)
Miles Point, Talbot County, MD	Surface-collected	Pre-Clovis core and blade	Artefacts eroded out of stratified soil horizons from shoreline	Lowery (2007) Collins *et al.* (2013)
Oyster Cove, Dorchester County, MD	Camp / Surface-collected	Clovis-aged lithics	Non-diagnostic lithics	Lowery *et al.* (2010)
Parsons Island, Queen Anne's County, MD	Camp	Laurel leaf bifaces / points [2]	Pre-Clovis laurel leaf points have been found *in situ* in palaeosols	Lothrop *et al.* (2016)
Paw Paw Cove, Talbot County, MD	Camp	Clovis points and other lithics	Large multicomponent along coastal shoreline	Lowery (1990, 2002)
Thunderbird, Warren County, VA	Quarry / Workshop	Late stage production Clovis points and associated lithics	A multicomponent Flint Run Jasper quarry	Gardner (1974, 1977)
Williamson, (44DW1), Dinwiddie County, VA	Camp / Quarry	Clovis point, and other lithics	A multicomponent Williamson chert quarry including a multi-activity Clovis locality	McCary (1951) McCary and Bittner (1978) Hill (1997) Peck (2004) Hranicky (2009b)
Southeast Subregion:				
Belle Mina, Limestone County, AL	Camp	Clovis points and other lithics	Excavations on two maintenance areas recovered the artefacts between 1989-1992	Ensor (2011) Anderson *et al.* (1994)
Big Bone Lick, Boone County, KY	Kill / Camp	Clovis points associated with mastodon remains	Possibly some of the first ever Clovis fluted points discovered, maybe as early as 1803 [3]	Tankersley (1985, 1989) Tankersley *et al.* (2009)
Big Pine, (38AL143), Allendale County, SC	Quarry / Camp	Clovis fluted bifaces, large blade assemblage	Multicomponent site, only 1 km away from the Topper site, and comparisons have been made on both blade assemblages	Goodyear (1999) Sain (2012)
Bone Lick, Boone County, KY	Isolate	Clovis fluted point	Small Clovis point made from Haney chert found near Big Bone Lick	Vesper (2016) [4]
Brooklyn, (3CG314), Craighead County, AR	Isolate	Clovis point	Ross County Clovis variant, part of the Arkansas Archaeological Survey	Morse and Morse (1983)
Coates-Hines, (40WM31),Williamson County, TN	Kill/Camp	Clovis lithics, but no points	Clovis artefacts no in direct association with mastodon, but butchery marks are present on bones	Breitburg *et al.* (1996) Deter-Wolf *et al.* (2011) Haynes & Hutson (2014) Grayson & Meltzer (2015)

Johnson, Davidson County, TN	Camp	Clovis preforms and other lithics	Clovis-Cumberland connection, multicomponent site	Barker and Broster (1996)
Macon Plateau, Bibb County, GA	Camp	Clovis point and other lithics, (found in 1935)	A multicomponent site best known for Mounds period	Kelly (1938) Anderson *et al.* (1994)
Page-Ladson, (8JE591), Jefferson County, FL	Camp	Clovis points, and other lithics, including unfluted Clovis	Clovis component overlying a good candidate for pre-Clovis occupation, an Aucilla River site, similar to Sloth Hole, has solid dates for the pre-Clovis component ~ 14,400 Cal yr BP	Dunbar (2006, 2007) Webb (2006) Halligan *et al.* (2016)
Pasquotank, (31PK1), Pasquotank County, NC	Surface / Camp	Clovis fluted point and other lithics	Surface-collected isolate that might indicate a buried stratified multicomponent site	Daniel *et al.* (2007)
Phil Stratton site, Logan County, KY	Camp - Surface	Fluted points and other lithics, Cumberland / Barnes association, rich blade industry present - these Cumberland points do not resemble Clovis	Extensive campsite first excavated in 2000, first open-air site of its kind, over eighteen hundred chert tools recovered	Gramly (2005) Gramly (2013) Gramly (2016)
Quad, Limestone County, AL [5]	Camp	Clovis fluted points, and other lithics	Discovered in 1951, it is a mult-component site of early Paleoindian and a later Archaic	Kleine (1953) Soday (1964) Cole (2005)
Sims, Kentucky Lake, TN	Surface?	Clovis points and other lithics	Multicomponent Paleoindian site, submerged for most of the year, deposits avbailable when the Kentucky Dam lowers the water level in the Kentuck Lake, in the Lower Tennessee River Valley	Adair (1976)
Topper, (38AL23), Allendale County, SC	Camp	Pre-Clovis component, as well as Clovis	Dates for the pre-Clovis and Clovis, and the gap between occupations are similar to that of Cactus Hill	Goodyear (1999) Smallwood *et al* (2013)
Wells Creek Crater, Stewart County, (40SW63), TN	Camp / Quarry	Clovis blades, and other lithics, including failed late-stage fluted points	Surface collections from the 1960s and later excavations revealed extensive occupation and manufacturing locales	Dragoo (1973) Gramly (2000)
Widemeier, (40DV9), Davidson County, TN	Camp	Clovis points and other lithics	Multicomponent camp localities, from Clovis through to Early Archaic	Broster *et al.* (2006)
Willie, (3PH23), Phillips County, AR	Isolate	Ross County Clovis variant	Surface-collected isolate and was part of the Arkansas Archaeological Survey	Morse and Morse (1983)

[1] This variant is definitely an example of the waisted Clovis that I identified in my main study. Both Lowery et al. (2011) and Brown (1979) call this a Fishtail Clovis and Lowery et al. also describes these points as being regionally uncommon (Lowery et al. 2011)
[2] These laurel leaf points are very similar to the Cinmar biface that sparked off the controversial Solutrean / Clovis debate (see Lowery 2009; Stanford and Bradley 2012, 2014; Eren et al 2013, 2015a; O'Brien et al 2014; Stanford et al. 2014; Eren et al. 2015a; Lowery 2015)
[3]. Bones of several mastodon were first collected in the late 1760s and was described as an elephant-like creature, Thomas Jefferson believed that American Indians were hunting and killing mastodons at the time (Jefferson 1810). A medical doctor was sent the Big Bone Lick site on instruction from Benjamin Franklin and found the first points (Cuming 1810) which later were identified as being Clovis
[4] This small Clovis point was found in the same tobacco patch as the Big Bone Lick points, made on a translucent chert known locally as Haney chert, a variety of Carter (Dennis Vesper pers.comm. email 2015)
[5] The Quad site is now recognised as being part of the group of sites along the Tennessee River; Quad, Pine Tree, and Stone Pipe localities (see Cambron 1955, 1956, 1958)

Table. A.2 Early Paleoindian sites that have Clovis association that do not appear in main body of the thesis, but the sites in bold do appear in my comparative C sample 2), and supplementary S sample 3) analysis. (Tables. 3.2, 3.3; 5.1)

Table. A.3 Midcontinent and Great Lakes region

SITE / LOCALE	SITE TYPE	CLOVIS ASSOCIATION	COMMENTS	PRIMARY SOURCE
Big Eddy, (23CE426), Cedar County, MO	Camp	Possible pre-Clovis component, Clovis points and other lithics	Possible pre-Clovis candidate. Clovis points part of the Clovis / Gainey association	Ray (1998) Ray *et al.* (1998, 2000) Lopinot *et al.* (1998, 2000) Hajic *et al.* (2007)
Burning Tree, Licking County, OH	Kill?	Pre-dates Clovis, possible evidence of pre-Clovis scavenging	Possible cut marks on ribs, adult killed in conflict with other mastodon	Fisher (1987) Fisher *et al.* (1994)
Butler, Branch County,MI	Kill / Camp	Clovis / Gainey points	Clovis / Gainey points associated with caribou butchery	Simons (1997)
Carlisle Cache, Warren County, IA	Cache	Clovis preforms, other lithics	One of the few Clovis caches to be professionally excavated	Hill *et al.* (2014)
Dugan Airfield, (11MO718), Monroe County,IL	Camp	Clovis points and other lithics	Hunting base, lithic assemblage contains local and non-local toolstone	Koldehoff and Walthall (2004)
Hawk's Nest, (11LK344), Lake County, IL	Camp / Workshop?	Mainly Clovis preforms; mid to late-stage manufacturing failures	Clovis / Gainey points, surface-collected, with non-local toolstone	Amick *et al.* (1997, 2000) Amick and Loebel (2002)
Hebior, (47KN265), Kenosha County, WI	Kill?	Undiagnostic lithics	Mammoth 85-90% complete, two bifacial fragments found adjacent to bones	Overstreet (1998) Overstreet and Stafford (1997) Overstreet and Kolb (2003) Yerkes and Weinberger (1998)
Martens, (23SL222), St. Louis County, MO	Surface / Camp	Clovis / Gainey points and other lithics	Surface-collected multicomponent site including Clovis.	Koldehoff *et al.* (1995) Martens *et al.* (2004)
Morrow-Hensel, Pierce County, WI	Camp / Habitation	Clovis points and other lithics	Site displays major reworking and recycling activities suggesting long-term occupation, primarily Hixton chert	Amick *et al* (1999) Hensel *et al.* (1999)
Nellie Heights, (33CO4), Coshocton County, OH	Isolate / Surface-collected	Fluted point resembling Clovis	Findspot close to the Welling site	Prufer and Wright (1970)
Nobles Pond, (33ST357) Stark County, OH	Camp / Habitation	Fluted points resembling Clovis and other lithics, large amount of scrapers	Large campsite and procurement areas, surface-collected, Clovis points part of the Clovis / Gainey association	Gramly and Summers (1986)
Pelland, Koochiching County, MN	Cache	Clovis blades [1]	The cache is located in the extreme north of Minnesota, an area that would have been periglacial in the late Pleistocene, the toolstone used on all nine blades was Knife River chert	Stoltman (1971) Schneider (1982)
Pleasant Lake, Washtenaw County, MI	Kill / Camp?	Possible post-Clovis-age butchery and disarticulation evidence.	Butchered mastodon, but no associated artefacts Dated at 10,395 ± 100 ^{14}C yr BP [2]	Fisher (1984) Shipman *et al.* (1984)
Pritchett-Kimbrell, Wayne County, IL	Cache	Clovis bifaces and flakes	All artefacts made on varieties of Burlington chert. One of the ovate bifaces could be one of the largest in North america	Gramly (in press)
Ready / Lincoln Hills, (11JY46), Jersey County, IL	Quarry / Camp	Clovis points, preforms and other lithics.	Assemblage represents the full range of Clovis fluted point manufacture	Morrow (1995) Howard (1998)

Red Wing, (BcHC-14), Ontario, CAN	Camp	Clovis point, and other lithics, including nearly fifty overshot flakes	Another of the Clovis / Gainey linked sites, it was iscovered in 1994 and excavated a year later. The vast majority of the assemblage is made on Fossil Hill chert, the assemblage is notable for the presence of overshot	Stork (1997) Eren and Desjardine (2014)
Rogers Shelter, (23BE125), Benton County, MO	Camp / Habitation	Fluted point resembling Clovis, but likely post-Clovis	Multicomponent site, possibly Clovis component, might be Dalton and post date Clovis	Wood and McMillan (1967) Ahler (1970) Ahler and McMillan (1976)
Schaefer, (47KN252), Kenosha County, WI	Kill?	Undiagnostic lithics,	Mammoth about 75% complete, biface fragment and chert flake found in direct association, if dates for the bones are correct, the site predates the Clovis time frame	Haynes (1992) Overstreet (1998) Overstreet and Kolb (2003) Joyce (2005)
Sheriden Cave, (33WY252), Wyandot County, OH	Camp / Habitation	Clovis point and other lithics and bone points	Clovis dates taken from bone point found in the cave with the other artefacts and bones of turtle and peccary	Tankersley (1997) Redmond and Tankersley (2005) Waters *et al.* (2009)
Trollinger Spring, (23HI210), Hickory County, MO	Camp / Kill	Fluted points resembling Clovis and other lithics	Possible direct association with mastodon bones and Clovis-aged lithics	Wood (1961, 1976)
Welling, Coshocton County, (33CO2), OH	Surface / Camp	Fluted points resembling Clovis and other lithics	Multicomponent site, Close to the Nellie Heights isolate, possibly related	Prufer and Wright (1970)

[1] The location of the Pelland cache has led to the suggestion that the site may have been under water during the late Pleistocenr, and that the cache could not be a Clovis assemblage (see Pettipas 2011). Kilby and Huckell (2013) tentatively accept it as being Clovis
[2] Possible post-Clovis survival of mastodon in the Great Lakes area (Woodman and Athfield(2009)

Table. A.3 Early Paleoindian sites that have Clovis association that do not appear in main body of the thesis, but the sites in bold do appear in my comparative C sample 2), and supplementary S sample 3) analysis. (Tables. 3.2, 3.3; 5.1).

Many of the Clovis sites and point assemblages are discussed more thoroughly in Koldehoff and Loebel (2009)

Table. A.4 Northern Plains region

SITE / LOCALE	SITE TYPE	CLOVIS ASSOCIATION	COMMENTS	PRIMARY SOURCE
Angus, (35NO101), Nuckolls County, NE	Isolate / Kill	Possibly a reworked Clovis point	Originally thought to be in direct association with mammoth	Figgins (1931) Holen (1986) Howard (2001) Holen *et al.* (2008)
Beach, Golden Valley County, ND	Cache	Clovis bifaces, 98% of assemblage	One of the most northerly Clovis caches in North America, location and type of artefacts suggest toolstone provisioning	Huckell and Kilby (2009) Huckell (2014)
Baller, Hitchcock County, NE	Cache	Clovis biface cache	Found in the early 1900s but not rediscovered in museum collection until 2009. Toolstone is a silicified chalk from the Smoky Hills	Osborn (2016)
Carter / Kerr-McGee, (48CA12), Campbell County, WY	Kill / Camp	Clovis fluted points and other lithics	A multi-component Paleoindian campsite. The Clovis levels yielded two Clovis fluted points in possible association with camel	Frison (1984)
Casper, (48NA304), Natrona County, WY	Surface	Clovis fluted point	Clovis point recovered with camel remains, no direct association	Frison (1974)
Crook County Cache, Crook County, WY	Cache	Late-stage Clovis points, and biface preforms	Cache is one of a group of biface caches in the region	Tankersley (1998a)
CW Cache, Lincoln County, CO	Cache	Clovis bifaces and large flakes	All pieces were made on Flattop chalcedony, a variety of White River Group (WRG) silicate, the cache was found in the 1990s	Holen and Muniz (2005)
Claypool, (5WN18), Washington County, CO	Surface / Camp	Clovis fluted point	Clovis point found in a multicomponent site which is also the later Paleoindian Cody point type-site, surface-collected	Dick and Mountain (1960) Stanford and Albanese (1975)
Dutton, (5YM37), Yuma County, CO	Kill / Camp	Clovis fluted point, and other lithics	Horse butchery evidence	Stanford (1979) Stanford and Graham (1985)
Gosper County Cache, Gosper County, NE	Cache	Early-stage Clovis bifaces	The two Clovis bifaces are made from Edwards chert	Myers and Corner (1986) Holen (2002)
Hell Gap, (48GO305), Goshen County, WY	Camp / Surface	Clovis points	Two Clovis points discovered with mammoth remains within 5 miles of the site	Irwin-Williams *et al.* (1973) Larson *et al.* (2009)
Jensen, Dawson County, NE	Kill?	Possible pre-Clovis, no lithics	No lithics are present, but there is alleged butchery evidence - dates ~19,000 ^{14}C yr BP	May and Holen (2005)
La Sena, Franklin County, NE	Kill?	Possible pre-Clovis, no lithics	No lithics are present, but there is alleged butchery evidence - dates ~14,000 ^{14}C yr BP	Myers and Corner (1986) Holen (2006)
Lamb Spring, (5DA33), Douglas County, CO	Kill?	No Clovis lithics	Fracture and bone modification of possible Clovis-age on mammoth bones at a multicomponent site	Stanford *et al.* (1981) Rancier *et al.* (1982) Holen and Holen (2012)

Lindsay, (24DW501), Dawson County, MT	Kill?	No diagnostic Clovis artefacts	Clovis or pre-Clovis butchery evidence	Davis and Wilson (1985)
Mahaffy Cache, Boulder County, CO	Cache	Clovis bifaces and flakes, no finished points	Predominant toolstone was Kremmling chert, known as Green River Formation chert	Bamforth (2014)
Powars II, (48PL330), Platte County, WY	Camp / Quarry (ochre)	Clovis fluted points	Multi-component site, from Clovis through to late Paleoindian, site indicates mining for ochre, currently the only Clovis red ochre quarry	Stafford *et al.* (2003) Frison *et al.* (2018)
Selby, (5YM36), Yuma County, CO	Kill / Camp	No Clovis lithics in direct association with mammoth bones	Had a possible pre-Clovis component, butchery evidence similar to Dutton	Stanford (1979) Stanford and Graham (1985)
Union Pacific Mammoth, (48CR182), Carbon County, WY	Kill?	Clovis aged unfluted point and other artefacts in same level as mammoth	Lithics typical of Clovis but non-diagnostic. Now believed to be later than Clovis.	Irwin *et al.* (1962) Irwin (1970) Frison (1978) Grayson and Meltzer (2002) Haynes *et al.* (2013) Prasciunas *et al.* (2016)
Wally's Beach, Alberta, Canada	Kill / Camp	Clovis points and other lithics	Lithics and butchery evidence associated with remains of horse and camel	Kooyman *et al.* (2006, 2012)

[1] *The Angus discovery and resulting debate on its genuineness, led to the point being described as "one of the earliest forgeries of a Paleoindian artifact" (Dixon 1999:7), an experienced flintknapper however argued (Patten 2002) that "the flintknapper that made the Angus biface had mastered the fluted point reduction sequence, and had the technical skill necessary to flute artifacts the entire length of both faces without severing the tip by overshot" (Holen et al 2008:359)*

Table. A.4 Early Paleoindian sites that have Clovis association that do not appear in main body of the thesis, but the sites in bold do appear in my comparative C sample 2), and supplementary S sample 3) analysis. (Tables. 3.2, 3.3; 5.1)

Table. A.5 Southern Plains and Desert Southwest region

SITE / LOCALE	SITE TYPE	CLOVIS ASSOCIATION	COMMENTS	PRIMARY SOURCE
Southern Plains subregion:				
Anadarko, Caddo County, OK	Cache	Clovis blade cache, with other lithics	Two of the artefacts made from Alibates chert, all the blades are on a greyish white unnamed chert, sources up 350 km distant in Texas	Hammatt (1970)
Aubrey, (41DN479), Denton County, TX	Surface / Camp	Clovis point and other lithics	Possible bison kill, possibly one of the oldest Clovis sites in North America, 11, 570 ± 70 ^{14}C yr BP	Ferring (1989, 1990. 1995, 2001) Haynes *et al.* (2007)
Burnham, (34WO73), Woods County, OK	Kill / Camp	Clovis or pre-Clovis lithics	A possible pre-Clovis bison kill? First recorded in 1986	Wyckoff *et al.* (1990) Buehler (1992) Wyckoff and Carter (1990)
Busse, (14SH1), KS	Cache	Clovis biface cache and other lithics	Discovered in 1968 and made on Smoky Hill jasper, less than 100 km	Hoffman (1995, 1997)
de Graffenried, Bell County, TX	Cache	Clovis bifaces and a late-stage preform	Privately collected in the 1930s and 1940s and is said to come from the Gault site, only came to attention in 1999 [3] All artefacts made from Edwards chert	Collins *et al.* (2007)
Debra L. Friedkin, (41BL1239), Bell County, TX	Camp	Pre-Clovis and Clovis lithics	Good pre-Clovis candidate, and other Paleoindian component part of the Buttermilk Complex	Waters *et al.* (2011b) Morrow *et al.* (2012) Jennings and Waters (2014)
Diskau, (14RY303), KS	Surface-collected occupation site	Clovis points and other lithics	Smoky Hill jasper predominant toolstone	Schmits (1987)
Gault, (41BL323), Bell County, TX	Camp	Pre-Clovis and Clovis points, and other lithics	Multi-component site, very close to the Debra L. Friedkin site, and is part of the Buttermilk Complex	Collins and Bradley (2008) Jennings (2012)
Hogeye, Bastrop County, TX	Cache	Clovis points, preforms and other lithics	Complete Clovis point reduction sequence present, the cache is comprised of over fifty late-stage bifaces	Jennings (2013) Lohse *et al.* (2014) Waters and Jennings (2015) [1]
JS Cache, (38BV180), Beaver County, OK	Cache	Clovis bifaces, blades, and flakes and presence of red ochre	Alibates chert predominate toolstone	Bement (2014) Graves *et al.* (2006)
Kanorado Locality, (14SN101, 105, 106), Sherman County, KS	Camp	Clovis diagnostic artefacts present but not in dated levels	Possible pre-Clovis Clovis, and Folsom components. Cluster of three stratified sites	Hoffman and Hesse (2003) Mandel *et al.* (2005)
Keven Davis, (41NV659), Navarro County, TX	Cache	Clovis blades	Blade assemblage very similar the blade cache found by Green at Blackwater Draw, NM	Green (1963) [2] Young and Collins (1989) Collins (1999a)

Kincaid Shelter, (41UV2), Uvalde County, TX	Camp	Clovis point, other lithics	Stratified Clovis deposits. A broken Clovis artefact represents the longest movement of obsidian.	Collins *et al.* (1989) Collins (1999a)
Levi Rockshelter, (41TV49), Travis County, TX	Camp / Occupation	Clovis point (basal fragment) in association with extinct fauna: bison, peccary, and horse.	Multicomponent site, Paleoindian and Archaic levels	Alexander (1963)
Lovewell Reservoir, Jewell County, KS	Kill?	Fractured bones thought to be pre-Clovis in age if the work of humans	Less than 1 km from the Eckles site and was at first thought to be perhaps linked.	Holen (1996, 2006)
McFaddin Beach, (41JF50), Jefferson County, TX	Surface-collected / Camp	Clovis points and other lithics	A number of Clovis locations that are eroding out of coastal deposits, possibly indicating a large occupation area	Turner and Turner (1994) Stright *et al.* (1999) Patterson (2000)
McLean, (41TA29), Taylor County, TX	Kill?	Clovis point with mammoth remains	Site discovered in 1929 by C. Ray. Some doubt whether the point and bones were in direct association	Bryan and Ray (1938) Ray (1942)
Pavo Real, (41BX52), Bexar County, TX	Camp	Clovis points, and other lithics	Multicomponent levels including Clovis and Folsom, first recorded in 1970, and excavations began in late 1970s and uncovered a large campsite, later excavations revealed more Clovis artefacts between 2000 and 2003	Collins *et al.* (2003)
Sailor-Helton, (14SW302), Seward County, KS	Cache	Clovis lithics, no fluted points, cores blades and unifacial tools	All blades are similar to the Blackwater Draw assemblage	Mallouf (1994)
Seminole, Gaines County, TX	Isolate	Clovis point	Isolate found 60 km from Blackwater Draw, NM, and is remarkably similar to # A-186 (BWD 06)	Slade (2018)
Wilson-Leonard, (41WM235), Williamson County, TX	Camp	Pre-Clovis and Clovis lithics	Probable pre-Clovis evidence above Clovis component, some later levels	Collins (1993, 1999b)
Yellow Hawk (41TA148), Taylor County, TX	Quarry	Clovis point, cores, blades and a hammerstone	Manufacture area and evidence of point production	Mallouf (1989)
Desert Southwest subregion:				
Billings, Santa Cruz County, AZ	Kill?	No artefacts	Clovis-age mastodon found in 1985, dates from associated deposits indicate an 11,005 ± 80 ^{14}C age	Haynes *et al.* (2016)
Burnet Cave, Eddy County, NM	Camp / Occupation	Clovis point	One of earliest Clovis points to be illustrated, as a Folsom-like point	Howard (1935b)
Mockingbird Gap, Socorro County, NM	Surface	Clovis points	Vast majority of the assemblage are basal, midsection, or tip fragments, local toolstone used	Weber and Agogino (1997) Huckell *et al.* (2006, 2008) Holliday *et al.* (2009) Hamilton *et al.* (2013)

Navarrete, (AZ-FF-9:3), Cochise County, AZ	Isolate	Clovis point and other lithics	Found in Greenbush Draw 50 m from the Naco site	Huckell (1981)
Schaldack, (AZ-EE-8-30), Cochise County, AZ	Isolate / Surface	Clovis point	Clovis point very similar to other San Pedro Valley Clovis points	Ayers (1970)
Ventana Cave, Pima County, AZ	Camp / Occupation	Clovis lithics and a unfluted point, said to be Clovis, now believed to be probably Plainview	Multicomponent Paleoindian levels.	Haury (1950) Huckell and Haynes (2003)

[1] *Confusion surrounded the discovery and recovery of the Hogeye cache, as the assemblage was said to have been divided up into two collections: the Hogeye cache, and the Wall / Mullins / Bastrop caches (see Waters and Jennings 2015). The cache also provides a rare opportunity to study the complete reduction sequence (see Callaghan 1979; Bradley 1982; Morrow and Morrow 2002a; Bradley et al. 2010)*

[2] *There is a blade cache reported from the Clovis type site at Blackwater Draw, New Mexico, that is said to be very similar in every way to the Keven Davis cache (Green 1963)*

[3] *Further evidence of the problems of sites that have been subjected to private collectors and artefact hunters at some sites*

[4] *This point; A-13230 (SHK 01), was discovered in 1966 by Mr. L. Escapule, it was referred to as the Escapule point for some time until the discovery of the Escapule points and was later renamed Schaldack to avoid confusion (Hemmings and Haynes (1969)*

Table. A.5 Early Paleoindian sites that have Clovis or Clovis-aged association that do not appear in main body of the thesis, but the sites in bold do appear in my supplementary analysis (Table. 3.3)

An overview of the caches and the toolstone sources and distances travelled are discussed by Kilby (2014a, 2014b)

Table. A.6 Southwest, Colorado Plateau, and Great Basin region

SITE / LOCALE	SITE TYPE	CLOVIS ASSOCIATION	COMMENTS	PRIMARY SOURCE
Acord Lake, Sevier County, UT	Isolate	Clovis fluted point	Made on a variety of red / yellow jasper, interesting flaking on the point	Tripp (1966)
Arlington Springs, (CA-SRI-173), Santa Rosa Island, CA	Camp / Occupation	No lithics	No diagnostic artefacts present in association with the human remains, dated to 10,960 ± 80 ^{14}C yr BP [1]	Orr (1962a, 1962b) Johnson *et al.* (2000)
Bonneville Estates, NE	Camp / Occupation	Clovis-age dates present	No Clovis diagnostic artefacts present, multicomponent levels	Goebel *et al.* (2003a, 2007)
(CA-KER-300), Kern County, CA	Camp / Surface	Clovis point and other later lithics	Multicomponent site, Clovis point may be a stray find as no other Clovis-aged artefacts are present, made on a non-local variety of obsidian	Zimmerman *et al.* (1989)
(CA-SBR-5330), San Bernardino County, CA	Isolate / Surface-collected	Clovis point	Basal section, found in two conjoining pieces, some scratching on flute present	Sutton and Wilke (1984)
Calico Hills, San Bernardino County, CA	Camp / Surface	Pre-Clovis lithics?	Extreme age for a pre-Clovis evidence (>70,000 yrs), is now said to be naturally produced	Leakey *et al.* (1968) Haynes (1973)
Castroville Mammoth, Monterey County, CA	Kill?	Clovis-age mammoth, no lithics	In 201130% of single mammoth remains were recovered from an articoke field, no sign of butchery, dates to about 14,000 Cal yr BP	Hylkema (2012)
Cerutti Mastodon, San Diego County, CA	Kill?	Pre-Clovis mammoth, no lithics	Extraordinary claims of early human / mastodon butchery association at 130.7 ± 9.4 ka (MIS 5)	Braje *et al.* (2017) Haynes (2017) Holen *et al.* (2017, 2018a, 2018b) Gruhn (2018)
China Lake, NAWS, Kern, Inyo, and Bernardino Counties, CA	Surface-collected	Pre-Clovis and Clovis-aged fluted points, nearly all basal sections	Pre-Clovis suggestion [2] as the points were described as being 'proto-Clovis' Made on local obsidian, cherts, rhyolite and jasper	Davis (1978) Davis and Panlaqui (1978) Rondeau (2003, 2005) Yohe and Gardner (2016)
Fairpoint, (CA-LAN-451), Los Angeles County, CA	Isolate [1]	Clovis late-stage fluted point	Discovered on a private residential construction site, this discovery represents the only known Clovis-era *in situ* site along the west coast	Rondeau (2006b) Stickel (2000)
Hell'n Mariah, (42MO1067), Millard County, UT	Camp	Clovis points, broken points, point fragments, and debitage	Single component site, maintenance and production of Clovis fluted points	Davis *et al.* 1996)
Huntingdon Reservoir, Sarpete County, UT	Kill?	No lithics	Clovis-age remains of mammoth, 10,850 ^{14}C yr BP, remains of a short-faced bear suggests maybe animal predation through gnaw marks on mammoth bones	Madsen (2000)

Manix Lake, San Bernardino County, CA	Camp / Workshop	Fluted points and other lithics, possibly Clovis-age points	Previously thought to be a pre-Clovis candidate, now disqualified	Simpson (1964) Meighan (1965) Glenman (1976) Moratto (1984) Bamforth and Dorn (1988) Warren (1996)
Lime Ridge, (42SA16857), San Juan County, UT	Camp / Surface	Clovis points and other lithics	First Clovis site discovered in Utah in 1985	Davis and Brown (1986) Davis (1989)
Rancho La Brea, Los Angeles County, CA	N/A	No lithics	Preserved fauna in the deposits, once believed to be butchered during pre-Clovis and Clovis times	Carter (1980) Harris (2015)
Rose Spring Site, (CA-INY-372), Inyo County, CA	Camp / Surface	Clovis point and other lithics	Bsalal fragment found in 1956, part of the 1950s excavations, made on local obsidian	Yohe (1992)
Skyrocket, (CA-CAL-629/630), Calaveras County, CA	Camp / Occupation	Clovis point, bifaces, fluted preforms, and over forty overshot flakes	Large well stratified multi-component site, represents the most significant Paleoindian site in California currently available for research	Pryor and Weisman (1990) Bieling *et al.*(1996) Rondeau and Pryor (2013)
Silverhorn, (42EM8), Emery County, UT	Isolate / Surface-collected	Clovis point	Discovered in a rockshelter in 1954, made a similar toolstone to Lime Ridge and Accord Lake points	Gunnerson (1956)
Tulare Lake, Kings County, CA	Camp / Surface	Clovis points and other lithics	Large number of reported of Clovis-aged points have been reported over a lengthy time	Hopkins (1991) Rondeau (2006a, 2014)
Tule Springs, Clark County, NE	Camp	Clovis-aged lithics associated with remains of extinct fauna	Obsidian flake in possible association with remains of horse, bison and camel,discovered in the 1930s, further excavations in the 1950s	Simpson (1933) Harrington and Simpson (1961) Wormington and Ellis (1967)
Twain Harte, Tuolumne County, CA	Isolate	Clovis point	A Classic Clovis form, made on Mt. Hicks obsidian. Found whilst digging postholes. A rare Classic Clovis specimen for California.	Rondeau and Dougherty (2009)
Witt Site, (CA-KIN-32), Kings County, CA	Camp / Surface	Clovis points and other Clovis-aged lithics	Large Clovis and later lithics assemblage collected from the Tulare Lake shoreline over a 30 year period by Mr. D Witt, mostly local cherts, but one point made on clear quartx crystal	Riddell and Olsen (1969)

[1] If dates are correct, the human remains pre-date the first level of occupation at Daisy Cave on the nearby San Miguel Island, dated to 10,390 ± 70 ^{14}C yr BP (Erlandson et al. 1996a, 1996b). The recently discovered pygmy mammoth skeleton (Mammuthus exilis) is dated at 12,840 ± 410 ^{14}C yr BP (Agenbroad 1998), that suggests the period between the latest evidence for mammoth and the earliest evidence for humans on the Northern Channel Islands is narrowing (Johnson et al. 1999)
[2] Although some areas of the China Lake Basin below an altitude of 665 m were available for human occupastion at the beginning of the Clovis, initial use of this area is likely to have been after 13,200 Cal yr BP (Rosenthal et al 2017)

Table. A.6 Early Paleoindian sites that have Clovis or Clovis-aged association that do not appear in main body of the thesis, but the sites in bold do appear in my supplementary analysis (Table. 3.3)

Table. A.7 Northwest region

SITE / LOCALE	SITE TYPE	CLOVIS ASSOCIATION	COMMENTS	PRIMARY SOURCE
Alkali Springs, Owyhee County, ID	Isolate / Surface	Clovis point fragment	Point would have been long, basal concavity shallow. Made on jade green semi-translucent agate with its nearest source on the Oregon / Idaho border	Huntley (1985)
Badger Mountain, Douglas County, WA	Isolate	Clovis fluted point	This point is the largest recorded, and it might be a hafted knife. Found very close to the Wenatchee cache	Gramly (1993)
Calvert Island, (EjTa-4), British Columbia, CAN	Surface / Camp?	Pre-Clovis footprints?	Human footprints in found in buried occupation levels are dated to 11,435 ± 30 to 11,295 ± 30 ^{14}C yr BP / 13,317 to 13,095 Cal yr BP, site was excavated first in 2014	McLaren *et al.* (2018)
Charlie Lake Cave, (HbRf-39),	Camp / Occupation	Post-Clovis fluted points and other lithics	Multicomponent Paleoindian site, first excavated in 1975, said to be occupied by 10,500 ± 80 ^{14}C yr BP post-dates Clovis [1]	Fladmark *et al.* (1988) Driver *et al.* (1996) Fladmark (1996) Driver (1999)
Heil Pond, (10OE1548), Owyhee County, ID	Camp / Cache??	Clovis points and other lithics	Currently only stratified Clovis site in Idaho with radiocarbon dates of 10,880 ± 260 ^{14}C yr BP	Reid *et al.* (2014, 2017) Haynes (2015)
Hoyt, Lake County, OR	Surface	Clovis points	Hafting adhesive and abrasions present on surface of obsidian	Tankersley (1994b)
Lake Cascade, (10VY563), Valley County, ID	Isolate	Clovis point	Clovis obsidian point made on Timber Butte obsidian	Titmus and Woods (1991) Reid *et al.* (2014)
Manis, Clallam County, WA	Kill	Pre-Clovis bone point	Bone implement in direct association with mastodon, 11,960 ± 17 ^{14}C yr BP	Gustafson *et al.* (1979) Waters *et al.* (2011c)
Paisley 5 Mile Point Caves, Lake County, OR	Camp / Occupation	Pre-Clovis lithics, human coprolites	Burnt faunal remains in hearths found in the 1940s, but association of the obsidian bifaces and flake tools with the coprolites was never accepted	Cressman (1942) Jenkins (2007) Gilbert *et al.* (2008) Jenkins *et al.* (2012) Hockett and Jenkins (2013)
Seagull Bay, (10PR89), Portola County, ID	Isolate / Surface	Clovis points	Two Clovis fluted points, made from varieties of obsidian	Hughes (2008) Reid *et al.* (2014)
Teton Valley sites, LH1, TH1, and LP1, Snake River, ID	Camp / Surface	Clovis points and other lithics	After a preform on non-local toolstone was found at LH1 [2], the other two localities were investigated	Pitblado and Fowler (2011)

Wasden site, (10BV30), Bonneville County, ID	Camp / Occupation	Post-Clovis lithics	The site consists of three caves, Owl Cave once thought to be of Clovis age is Folsom.	Miller (1982)
Wenas Creek Mammoth Site, (45YA1083), Yakima County, WA	Kill / Camp	Pre-Clovis lithics	Remains of mammoth and bison are present, and are associated with two possible pre-Clovis flakes	Lubinski *et al.* (2007, 2014a, 2014b) Lubinski (2016)
Wilson Butte Cave, Jerome County, ID	Camp	Pre-Clovis western stemmed points and other lithics	Bones from extinct fauna, including mammoth, horse, and camel date from 16,000 to 9,000 ^{14}C yr BP [3]	Bryan and Touhy (1999)
Yukon Harbour, (45KP139), Kitsap County, WA	Isolate / Surface	Clovis point	Clovis point is very similar to the points in the East Wenatchee cache, and was made on a chert sourced east of the Columbian River [4]	LeTourneau (2010)

[1] Although the Charlie Lake site clearly post-dates Clovis, and the assemblage does not resemble Clovis, for some reason Eren and Buchanan (2017: Fig. 4) suggest Charlie Lake is "a prominent Clovis site", without actually explaining why
[2] The Clovis point found at LH1 was made on an exotic butterscotch coloured volcanic material, this, and the fact it was said to be in pristine condition, originally led to the suggestion it may have been part of a cache (Pitblado and Fowler 2011:71)
[3] Obsidian hydration (OH) dates taken on the western stemmed points place them at ~ 5,000 Cal yr BP and therefore place them a lot earlier than Clovis, and cannot be associated with the fauna (Bryan and Touhy 1999)
[4] The Yukon Harbour Clovis point is one of a number of western Washington locations with fluted points and early evidence of human activity associated with late glacial peat bogs (Meltzer and Dunnell 1987)

Table. A.7 Early Paleoindian sites that have a Clovis association that do not appear in main body of the thesis

A.3 Comment: further north and farthest south

The earliest identifiable archaeological cultures in Alaska are not Clovis. Some fluted points are present at numerous locations, but none of these have been reliably dated (Bever 2006), and as a result, archaeologists have not been able to ascertain whether Alaskan fluted points were older than, contemporary with, or younger than Clovis. Technologically, Alaskan fluted points are very distinct from Clovis points. Similar points to those found in Alaska have been reliably dated to 10,500 to 9,500 ^{14}C yr BP at sites in Alberta and British Columbia, in Canada, and are considered to be a post-Clovis technology (see Carlson 1991; West 1996).

One possible Clovis candidate for an Alaskan association, or at the very least a Clovis-aged fluted point technology, is from Serpentine Hot Springs (Goebel *et al.* 2013). The site, (BEN-192), is located in the Seward Peninsula, western Alaska, Bering Land Bridge National Preserve. It provides the first empirical evidence in trying to resolve the position of where Alaskan fluted point technology fits into the Clovis origins debate. The lithic assemblage consists of over fifteen-hundred debitage pieces, and thirty tools, the fluted points are represented by basal section fragments. The toolstone present in the assemblage are four varieties of chalcedony and come from sources along the Brooks Range, some 300 km to the northeast (Goebel *et al.* 2013). The date of the assemblage from Serpentine Hot Springs falls within the later Clovis age range, 10,300 ± 100 ^{14}C yr BP (Young and Gilbert-Young 2007), the dates were an average taken from wood charcoal samples. The data from the site suggests that the fluted points are too young to be antecedent to Clovis, but after decades of looking, there is evidence of late Pleistocene humans in Beringia (*e.g.* Goebel *et al.* 2003; Mulligan and Szathmáry 2017; Graf and Buvit 2017). Further south, there was a suggestion that there was a prominent Clovis site on the very western edge of the ice-free corridor in British Columbia (Eren and Buchanan 2016:2), Charlie Lake Cave however, clearly post-dates (Table. A.7).

At present the radiocarbon dates for the Charlie Lake Cave site, along with the Alaskan younger age estimates, supports the post-Clovis link between the northern regions of North America and Arctic. Perhaps, as suggested by Stanford and Bradley (2012), "*the technology of these Canadian points is more like that of some of the post-Clovis fluted points found in the northeastern and upper midwestern United States and eastern Canada"*. And that perhaps all these point types "*represent Clovis-derived people who followed the retreating ice front northward through the opening corridor into Alaska"*.

As discussed above, fluted point technology was first implemented by Clovis and the widespread traces of fluted points left behind, help to support the expansion of Clovis across North America south of the ice sheets. The presence of fluting in South America has been linked to the hypothesis that a single, pan-continental colonisation event occurred through pioneering Clovis groups (see Bell 1960; Mayer-Oakes 1986; Ardila Calderon and Politis 1989; Ardila Calderon 1991; Gnecco 1994; Jackson 1995; Pearson and Ream 2005). A recent study has identified Clovis, and fluted points that are similar to Clovis south of the study area above (Pearson 2017).

A large concentration of fluted points that have been described as being very similar to the classic Clovis form, have been found on the eastern side of the gulf of California, Mexico (Sánchez *et al.* 2014; Sánchez 2015; Sánchez and Carpenter 2015) and may represent a southern extension of Clovis point distribution. In Belize at the Ladyville site, two Clovis points were recovered (Hester 1979; Hester *et al.* 1980, 1981, 1982), and a third from the Pine Ridge site was reported (Valdez and Aylesworth 2005; Lohse *et al.* 2006). Further south, a complete obsidian point was found near San Rafael, Guatemala (Coe 1960). Some years later, a basal fragment of another fluted point was discovered at Los Tapiales (Gruhn and Bryan 1977), as well as a complete point from the Chajbal localities in the Quiche Basin

(Brown 1980). Other isolate / surface-collected occurrences have been recorded and published (see Perrot-Minnot 2013, 2014).

No Clovis, or fluted points resembling Clovis have yet to be discovered, or reported being found, in Honduras or Nicaragua (Pearson 2017). They reappear in El Salvador and Costa Rica, where in 1903 a fluted point was discovered (Bird and Cooke 1978), but was not recognised as Clovis at the time (Swauger and Mayer-Oakes 1952), I would classify this point as a waisted Clovis [28]. Since this discovery no fewer than twenty fluted points resembling Clovis have been found in the Turrialba Valley, central Costa Rica (see Snarskis 1979). And in Panama, two Clovis points were discovered along the Canal Zone (*e.g.* Cooke and Ranere 1992; Ranere and Cooke 1995, 1996, 2002; Cooke 1998; Ranere 2000), and along the Azuero Peninsula a quarry / workshop has been identified (see Pearson 2003).

There has been a suggestions for the relationship between the South American fishtail projectile points (FPP) and Clovis and have been well-discussed elsewhere (see Bryan 1973; Rouse 1976; Snarskis 1979; Ranere 1980; Lynch 1983; Schobinger 1988; Politis 1991; Morrow and Morrow 1999; Pearson 2017). Each of the different models has its own model set out, but all share the idea that fluting was a northern innovation that first appeared in Clovis.

For a breakdown of the sites, the Clovis assemblages and detailed map of the study area above see Pearson (2017:208).

[28] After carrying out a literature review of the farthest south material, most of the fluted points resembling Clovis, are indeed the waisted Clovis variant. This is quite an interesting finding, and may well need further investigating (see Faught 2006)

Appendix. B

Data collection: list of institutions and collections of Clovis points accessed for this research

B.1 Institutions

Smithsonian Institution, Washington DC
2010, 2011, 2012, 2014, 2015 - Prof. D. Stanford
Original and replica casts of Clovis points from all over North America
The Eichenberger Cast Col:
Marie Wormington Cast Col:

Denver Museum of Natural History and Science, Denver CO
2011, 2013 - Dr. S. Holen
Originals of Colorado Clovis points, and replica casts of Clovis points from across North America
Marie Wormington Cast Col:

Arizona State Museum, Tucson, AZ
2011, 2014 - Dr. V. Holliday
Original Clovis points from the San Pedro Valley Clovis sites, and replica casts of Clovis points from across North America
C.V. Haynes Jr. Cast Col:

Anthropology Museum, University of Missouri, Columbia, MO
2010 through to 2017 - Ms. Candace Sall
Access to the archive and photographic database for the Clovis replica cast collection from the J.A. Eichenberger Col:
The Eichenberger Cast Col:

B.2 Private collections

Mr. Tony Baker's private collection of early Paleoindian artefacts
2011, 2012, 2013, 2014, 2015 - Denver CO

Mr. Carl Yahnig's private collection of Kentucky Clovis artefacts
2012, 2014 - Christian County KY

B3 Miscellaneous collections

The British Museum, London, UK

2010 through to 2017 - Prof. Nick Ashton

Original Clovis fluted points and associated archive from the collection of Paleoindian points acquired by the museum from Col T.C. Kelly in Texas in 1962

T.C. Kelly Col:

The British Museum, London, UK

2012 through to 2017 - Mr. Ian Taylor

Original Clovis fluted points and associated archive from several collections of stone tools acquired by the museum from several sources from the 19th and 20th century from North America

British Museum Reserve Col:

Appendix C

Clovis point data collection: artefact recording sheet, photographic and metric databases

ARTEFACT CHARACTERISTICS RECORD SHEET

METRICS **SKETCH OF POINT TO SCALE**

a. **Maximum Length (mm)**

b. **Basal Width (mm)**

c. **Basal Concavity Width (mm)**

d. **Depth of Basal Concavity (mm)**

e. **Length of Fluting or Basal Thinning (mm)**

f. **Length of Edge Grinding (mm)**

g. **Maximum Width (mm)**

h. **Maximum Thickness (mm)**

POINT DETAILS

Artefact ID ___________ **Institution / Owner** ____________________

Remarks ____

____

____

Date ___________

C.4 Recording methodology

For the methodology of the recording of Clovis points, I used a unique three-lettered, two-figured identifier. It uses three letters from the point's findspot or location - i.e. BWD from Blackwater Draw; and the two numbers relating to the specimen - i.e. 01: BWD 01 the first Clovis point from Blackwater Draw in my dataset. When only the county of the point is known, I took two letters from the county name, and the third letter was a C signifying the county - i.e. SLC a point from St. Louis County. If only the state was known, I used the symbol ~ to represent no provenance, and the second two letters from the recognised state abbreviation list (see Appendix. D) - i.e. ~IL a specimen from somewhere in Illinois.

Appendix. D

U.S state abbreviations and Smithsonian Institution trinomial index

D. 1 State abbreviation and associated region

Alabama	AL	Southeast	Alaska	AK	Further North
Arizona	AZ	Desert Southwest	Arkansas	AR	Southeast
California	CA	Southwest	Colorado	CO	N Plains
Connecticut	CT	Northeast	Delaware	DE	Mid-Atlantic
Florida	FL	Southeast	Georgia	GA	Southeast
Idaho	ID	Northwest	Illinois	IL	Midcontinent
Indiana	IN	Southeast	Iowa	IA	Midcontinent
Kansas	KS	S Plains	Kentucky	KY	Southeast
Louisiana	LA	Southeast	Maine	ME	Northeast
Maryland	MD	Mid-Atlantic	Massachusetts	MA	Northeast
Michigan	MI	Midcontinent	Minnesota	MN	Midcontinent
Mississippi	MI	Southeast	Missouri	MO	Midcontinent
Montana	MT	N Plains	Nebraska	NE	N Plains
Nevada	NV	Southwest / Gt. Basin	New Hampshire	NH	Northeast
New Jersey	NJ	Northeast	New Mexico	NM	Desert Southwest
New York	NY	Northeast	North Carolina	NC	Southeast
North Dakota	ND	N Plains	Ohio	OH	Midcontinent
Oklahoma	OK	S Plains	Oregon	OR	Northwest
Pennsylvania	PA	Northeast	Rhode Island	RI	Northeast
South Carolina	SC	Southeast	South Dakota	SD	N Plains
Tennessee	TN	Southeast	Texas	TX	S Plains
Utah	UT	Southwest / Gt. Basin	Vermont	VT	Northeast
Virginia	VA	Mid-Atlantic	Washington	WA	Northwest
West Virginia	WV	Mid-Atlantic	Wisconsin	WI	Midcontinent
Wyoming	WY	N Plains	Canada	CAN	Northeast, Great Lakes, Northern Plains
Mexico	MEX	Desert Southwest			

D.2 Smithsonian Institution trinomial Clovis site index

Smithsonian trinomials are unique identifiers assigned to archaeological sites in many states in the United States. They are composed of one or two digits coding for the state, typically two letters coding for the county or county-equivalent within the state, and one or more sequential digits representing the order in which the site was listed in that county. The Smithsonian Institution developed the site number system in the 1930s and 1940s. (Trinomials are now assigned by the individual states.) The 48 states then in the union were assigned numbers in alphabetical order. Alaska was assigned number 49 and Hawaii was assigned number 50 after those states were admitted to the union. There are no Smithsonian trinomial numbers assigned for the District of Columbia.

Most states use trinomials of the form "nnAAnnnn", but some specify a space or dash between parts of the identifier, i.e., "nn AA nnnn" or "nn-AA-nnnn". Some states use variations of the trinomial system. Arizona, California, Connecticut, Maine, Rhode Island and Vermont use two-letter abbreviations of the state name instead of the Smithsonian number. Alaska uses three-letter abbreviations for USGS map quadrangles in place of the county code. Arizona uses a five-part identifier based on USGS maps, specifying quadrangles, then rectangles within a quadrangle, a sequential number within the rectangle, and a code identifying the agency issuing the sequential number. California uses a three-letter abbreviation for counties. Connecticut and Rhode Island do not use any sub-state codes, with site identifiers consisting of the state abbreviation and a sequential number series for the whole state. Delaware uses a single letter code for counties and adds a block code (A-K) within each county, with sequential numbers for each block.

http://www.wikiwand.com/en/Smithsonian_trinomial#

Appendix. E

Dating: calibrated and radiocarbon ages

E.1 Conversion tables: radiocarbon ages (^{14}C yr BP) roughly calibrated to calendar-year ages (Cal yr BP)

MATCHING RADIOCARBON DATES TO CALENDER DATES	
^{14}C yr BP	**Cal yr BP**
20,000	23.950
19,500	22,950
19,000	22,450
18,500	21,950
18,000	21,450
17,500	20,950
17,000	20,200
16,500	19,950
16,000	19,150
15,500	18,450
15,000	17,950
14,500	17,450
14,000	16,950
13,500	16,200
13,000	15,350
12,500	15,085
12,000	14,065
11,500	13,350
11,000	13,000
10,500	12,620
10,000	11,350
9,500	11,030
9,000	10,200

Table. E.1 Simplified conversion table of radiocarbon and mid-points of calendar-year ages before present relating to pre-Clovis, Clovis and post-Clovis in this study. after Haynes 2002:274 but also see Stuiver et al. (1998)

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