CLOVIS POINTS ON FLAKES:
A TECHNOLOGICAL ADAPTATION FOR LONG DISTANCE LITHIC TRANSPORT

by

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Thesis directed by Associate Professor Julien Riel-Salvatore

ABSTRACT

Clovis technology has long intrigued archaeologists. Many studies--both experimental and refitting--have reproduced Clovis replicas, and by doing so, present a current understanding for point production. Even though the production sequence for Clovis points is generalized, not all points display the stereotypical features from that production sequence. These “abnormal” points preserve a prominent detachment flake scar and are relatively rare in the archaeological record. A sample of Clovis points from the central Great Plains is analyzed to determine the frequency and significance of points that maintain this flake scar relative to typical points. The origin of the raw material for the two subsets of points is also investigated, and this reveals that more Clovis projectile points are manufactured on flakes with little additional retouch as the distance from the lithic source increases. This suggests that Clovis points on flakes represent a technological adaptation of central Great Plains Clovis peoples focused on lithic conservation by substituting flakes for bifacial preforms as a way to maximize the utility of raw material from distant sources.

The form and content of this abstract are approved. I recommend its publication.

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CHAPTER I
INTRODUCTION

The finely-made hunting points associated with Clovis culture have always fascinated New World archaeologists and served as the center for many research topics. Many studies have demonstrated high residential mobility through lithic analyses (e.g. Huckell et al. 2011, Surovell 2003), but few have demonstrated any, if at all, technological innovation created through the means of this high mobility. The Clovis people who traversed the Great Plains of North America would have faced many lithic obstacles as raw material sources are few and far between (Holen 2001). It is this fact that raises the question of whether these highly mobile foragers innovated or adapted their tool-production strategies as a means to compensate for the vast distances between lithic sources.

A sample of 114 Clovis projectile points that includes 104 points on preform blanks and 13 points on flake blanks are analyzed using the presence of a detachment flake scar and the relationship this feature, or lack-there-of, shares with distance from known lithic source. Furthermore, morphological data (e.g. length, width, thickness) is tested for the presence of any relationship either between blank type and distance from source. These analyses test the question of whether points on flake blanks represent a technological adaptation in Clovis point production strategy reflecting the increasing distance between raw material sources. As the distance from source increases, the amount of usable lithic material would decrease proportionally. This would therefore require innovative knapping procedures to maintain the integrity and usability of their
tool-kits. I argue here that points on flake blanks do in fact represent an alternative point production strategy by Clovis tool-makers and not simply stylistic variations through the Clovis point production strategy. These points reflect the flexibility needed to produce viable hunting points as the transported usable raw-material decreases when distance from lithic sources increase.

To demonstrate this relationship, Chapter II briefly summarizes the history of Clovis research and includes a detailed description of the Clovis techno-complex. It also details the current models of Clovis point production and both defines and describes how points on flake blanks differ. Chapter III introduces Human Behavioral Ecology (HBE) and how it can be used to understand functional variation in lithic technologies. HBE provides a useful framework to explicate why Clovis knappers would have begun point manufacture with a flake or informal flake tool rather than a larger flake needing extensive modification to produce a viable hunting point. Chapter IV describes the sample used and the statistical methods applied for analysis. The results of these analyses are included in Chapter IV, but are discussed in much further detail in Chapter V.

In sum, the evidence presented here shows a proportional increase in points on flake blanks as the distance from source also increases. When considering the included morphological data, these points themselves do not represent anomalies in the Clovis techno-complex, but simply reflect an alternative point production strategy. This alternative point production strategy begins with the assumption that Clovis culture practiced high residential mobility as described by Surovell (2000). Evidence for this mobility in Clovis culture resulted from the high frequency of exotic materials in Clovis
tool-kits (Bradley et al 2010; Collins 1999; Holen 2001; Huckel et al. 2011; Sellet 2006; Waters et al. 2011b). However, the occurrence of exotic raw material may in fact not represent high residential mobility, but rather reflect social exchange between regional sub-groups of technologically defined cultures (Bamforth 2009). Regardless of why, evidence for long-distance lithic transport is apparently a defining feature of Clovis culture.

This fact is likely to have imposed specific constraints on their technological decision making. For instance, as raw material quantity decreases through use, Clovis toolmakers might have altered their point production process to ensure the availability of lithic utility for unforeseen occurrences. Possible evidence suggesting an alternative point production process may stem from a series of Clovis points maintaining their detachment flake scar. The presence of a remnant flakes scar represents a different manufacturing sequence than typical points. This observable feature can be tested empirically to support the hypothesis that Clovis points on flakes reflect an alternative technological strategy to maximize high-quality lithic material utility in the context of long distance transport.

This argument does not contend that distance per se serves as the determinant of alternative technological practices; rather, distance acts as proxy for extended life-histories of lithic technologies. For instance, the difference between stone transported 100km and stone transported 900km is that the latter has covered more distance and was presumably carried for longer periods of time. This increase in distance and time within the context of lithic life-histories can be used to infer higher potential rates of retooling events a group would have gone through. These retooling events could, in some cases,
have selected for technological innovation when high-quality raw materials were rare, potentially as a result from risk-reduction behaviors explained by HBE.

Overall, Clovis technology descriptions rely heavily on site-specific analyses such as that from the Sheaman site (Bradley et al. 2010) and the Gault site (Waters et al. 2011b). Clovis technology, as well as that of other Paleoindian cultures, can and should incorporate regional-based assemblage analyses. With a sample that incorporates Clovis points from eastern Colorado to eastern Nebraska and Kansas, this research does use a regional approach. This provides the means needed to understand clearly, how and why, Clovis foragers adapted their tool kits to their local environment and how they successfully occupied the Great Plains.
CHAPTER II

NEW WORLD ANTIQUITY AND CLOVIS CULTURE

The association in New World archaeology between early humans and extinct megafauna is relatively recent. It was not until the 1920s when evidence demonstrated humans had co-existed with an extinct species of bison (*Bison antiquus*). Early excavations by J.D. Figgins outside Folsom, New Mexico yielded five projectile points associated with several dozen *Bison antiquus* individuals (Figgins 1927). This discovery pushed the antiquity of American archaeology further back than previously assumed. Several years later, in 1932, early human artifacts were found associated with proboscidean remains near Dent, Colorado (Figgins 1933). The Dent site contained several bifacial points similar to the points recovered at Folsom but appeared to be stratigraphically older (Cassells 1983). These points were initially referred as the Llano complex (Sellards 1952), but later re-designated as the Clovis techno-complex (Bradley 1993; Hayes 2002).

Stratigraphically, Clovis was dated to between 13,000 and 11,000 years BP and it was not until radiocarbon dating became possible to absolute date sites like Dent to validated these data. As research continued the investigation of when people first arrived in the Americas, several other accepted Clovis sites yielded datable materials for direct dating of these early human occupations in North America (Table 1). From this data, it becomes apparent Clovis foragers became widespread across North America within a few centuries all while occupying vastly different environments. This rapid expansion of what were presumably the first people in North America is known as the Clovis First hypothesis. However, this rapid expansion was quickly followed by the seemingly rapid
disappearance of Clovis cultural diagnostics, more specifically, Clovis projectile points. This sudden appearance followed by the quick disappearance of Clovis cultural diagnostics marks one of the most problematic components of the Clovis First hypothesis (Waters and Stafford 2007).

Table 1: Accepted dates from sites containing Clovis-diagnostics. Taken from Waters and Stafford 2007.

<table>
<thead>
<tr>
<th>Site</th>
<th>Date in RCYBP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lange-Ferguson, South Dakota</td>
<td>11,080 ± 40</td>
</tr>
<tr>
<td>Sloth Hole, Florida</td>
<td>11,050 ± 50</td>
</tr>
<tr>
<td>Anzick, Montana</td>
<td>11,040 ± 35</td>
</tr>
<tr>
<td>Dent, Colorado</td>
<td>10,990 ± 25</td>
</tr>
<tr>
<td>Paleo Crossing, Ohio</td>
<td>10,980 ± 75</td>
</tr>
<tr>
<td>Domebo, Oklahoma</td>
<td>10,960 ± 30</td>
</tr>
<tr>
<td>Lehner, Arizona</td>
<td>10,950 ± 50</td>
</tr>
<tr>
<td>Shawnee-Minisink, Pennsylvania</td>
<td>10,935 ± 15</td>
</tr>
<tr>
<td>Murray Springs, Arizona</td>
<td>10,885 ± 50</td>
</tr>
<tr>
<td>Colby, Wyoming</td>
<td>10,870 ± 20</td>
</tr>
<tr>
<td>Jake Bluff, Oklahoma</td>
<td>10,765 ± 25</td>
</tr>
</tbody>
</table>

With the rapid expansion, Clovis foragers quickly occupied vastly different biomes. These data also present problems for the Clovis-first theory (Gruhn 2004; Miotti 2204; Waters and Stafford 2007; Waters et al. 2011). Gruhn (2004) demonstrates that all major environmental zones in South America were already occupied by locally adapted cultures with independent subsistence strategies before 11,000 RCYBP. In fact, big-game hunting associated with Plains Clovis subsistence (Wagespack and Surovell 2003) was less common in South American groups. For instance, Dillehay (2009) suggests foragers in South America developed a more broad-based diet that resulted in a reduction in mobility by including more marine and floral resources ca. 13,000 CALYBP. Sites
like Quebrada Jaguay, off the southern coast of Peru, also exhibit food storage and grinding stone technologies by ca. 10,800 CALYBP allowing for speculation that more broad-based subsistence behaviors were practiced before Clovis technology appeared in North America. This contrasts with North American early Paleoindian subsistence strategies where large mammal hunting was the predominant specialization (Frison 1993). This idea of big-game specialization applies mostly to foraging groups occupying the grasslands of the Great Plains where faunal diversity is low (Hill 2007). Elsewhere, such as the more diverse foothill and mountainous regions, Clovis exhibited a more diverse faunal and floral resource exploitation.

Before Clovis hunters harvested proboscideans, their early American ancestors also targeted these massive calorie packages. Early pre-Clovis sites such as La Sena, Nebraska and Lovewell, Kansas displayed targeted mammoth hunting by early humans (Holen 2006). Dating to 18,000 ± 190 - 18,440 ± 145 RCYBP (La Sena) and 18,250 ± 90 RCYBP (Lovewell), these kill/butcher sites represent some of the oldest evidence for early human occupation in North America. Although critiques suggest natural processes are the cause for the taphonomic destruction of the mammoth bones, Holen (2006) argues that arrangement of bones and their debris reflects a human agency. For instance, trampling experiments suggest the less robust bones of a deceased animal will suffer more extensive damage than heavier bones such as the limb bones with thicker cortical walls (Crader 1983; Haynes 1984). At both La Sena and Lovewell, the smaller bones were intact observing virtually no damage; whereas the limb bones were extensively spirally fractured and several large pieces of cortical bone exhibited both unifacial and bifacial flaking (Holen 2006). Overstreet (2004) summarizes two pre-Clovis mammoth
kills in Southeastern Wisconsin dated to ca. 13,500 RCYBP. Early excavations yielded several lithic artifacts including waste debitage, bifacial chert edge, two bifacial knives, and a chopper associated with the mammoth remains (Overstreet 1996; Overstreet et al. 1995; Joyce 2006). Furthermore, use-wear and residue analyses identified micro-wear and flesh residue on both knives (Yerkes and Weinberger n.d).

These data demonstrate the importance of megafauna to early Paleoindian populations. Their importance would have created the technological guidelines shaping the human agency specifically gear towards utilitarian technologies. These technologies would have included hunting weaponry and the behaviors needed to both maintain and produced viable hunting tools within a given context. The example used within this research focuses towards Clovis hunters on the Great Plains where megafauna were prevalent and lithic sources were not.

The Origins of the Clovis Techno-Complex

Lithics recovered from the Debra L. Friedkin (DLF) site in central Texas may possibly shed light onto the origins of the Clovis techno-complex (Waters et al. 2011a). With a total of 15,528 lithic artifacts excavated, this assemblage (Buttermilk Creek Complex) included bifaces (n=12), retouched flake tools (n=23), blades (n=5), bladelets (n=14), one discoidal core, and one polished piece of hematite (Waters et al. 2011a). OSL dating from 18 samples ranged from ca. 14,000 -17,500 CALYBP with the conservative age estimate of 15,500 CALYBP as the overlap between all but three samples. Of the 12 bifaces, ten represent late-stage biface reduction fragments, one is lanceolate shape and may be a point preform, and the last biface possible represents a chopper or adze. All of
the blades and bladelets display at least two dorsal ridges and microscopic analysis revealed some had use-wear consistent with both hard and soft organic materials (Waters et al. 2011a). The retouched flake tools included 17 scrapers, fours notches, one graver, and one bifacially retouched artifact. Of the macrodebitage (n=13,204), 834 pieces of chipped stone retained a platform. 51% were classified as biface thinning flakes that included one distal overshot flake fragment, three partial overshot flakes, and 10 end-thinning flakes. For a further discussion of potential Pre-Clovis lithic assemblages, see Goebel et al. (2003).

The debate between Pre-Clovis occupation and the Clovis-first hypothesis is a long ways away from resolution. However, most have come to accept the evidence suggesting humans were in North America before the emergence of the Clovis techno-complex. Those who maintain the Clovis-first view suggest the long distance lithic transport seen in Clovis tool-kits is the result of high residential mobility, which would be expected for the rapid expansion of human groups. However, Bamforth (2009) argues that long distance lithic transport could have been the result of exchange between regional groups with smaller domains. Although his argument focuses on post-Clovis cultures where more residential camps have been recovered, these sites show higher frequencies of local stone usage for informal tool types while exotic stone was used solely for point manufacture. This observation is consistent with Clovis assemblages. Because of this, it is problematic to infer range size based only on projectile points and there needs to be better explanations for why long distance lithic transport is seen for point production (Bamforth 2009). Furthermore, the use of flakes for points at further distances may support Bamforth’s (2009) suggestion that group exchange of raw material
occurred through the exchange of finished points and preforms. Lastly, if points on flake and long distance lithic transport do not reflect high residential mobility, these data challenge Clovis-first models and open the door for further research into the peopling of North America.

The Clovis Techno-Complex

Overall, the Buttermilk Creek Complex represents high residential mobility through the evidence of an overall small lightweight portable tool kit based within bifacial and blade technologies. Furthermore, evidence of both soft and hard organic materials suggests technologies incorporating bone, antler, ivory, and wood. These data, along with the evidence of overshot flaking, provides a possible insight into an ancestral techno-complex that gave rise to Clovis culture, which is discussed below.

The Clovis complex dates to between 12.8-13.1 thousand calibrated years ago (kya) (Bradley et al. 2010; Buchanan and Collard 2007; Erlandson et al. 2011; Goebel 2008; Smallwood 2010; Waters et al. 2011; Waters and Stafford 2007). While a number of Pre-Clovis sites are known (e.g. Waters et al. 2011a), the Clovis culture arguably represents the earliest distinctive and widespread lithic tradition in the North American archaeological record (Bradley 1991; Frison 1991). Finely-made fluted projectile points are the most distinctive feature of the Clovis complex (Smallwood 2012:690) and are distinct from other fluted point types such as Folsom which tend to be smaller, bear a more invasive channel flake, and are different in overall morphology (Collard et al. 2010: 2513). The focus of projectile points in Paleoindian research reflects the problematic fact that for those time periods points are almost the only cultural-historical diagnostic
Furthermore, because they conform to distinctive morphologies with aesthetic investments, resulted from complex production sequences, and great efforts were taken to procure specific raw materials to make them, points potentially offer greater inferences of behavior when compared to more informal tool types seen in early Great Plains Paleoindians such as Clovis.

Clovis lithic procurement strategies indicate long distance lithic transport, as many assemblages contain stone originating several hundred kilometers away (Holen 2011; Huckell et al. 2008; Sellet 2006). For instance, Huckell et al. (2011) describe the Beach Clovis cache located in western North Dakota as containing lithic material from both local (<20km) and exotic sources (>500km). Likewise, Collins (1999) and Holen (2001, 2004) describe the transport of lithic material by Clovis foragers over more than 900km. These examples show just how far lithic material traveled within Clovis organization whether by high-residential mobility or trade. Kelly and Todd (1988:238) summarize Clovis, and more generally Paleoindian, lithic technology as “designed to be transportable, have long-term utility, and be of use in areas where only limited number of stone sources might have been known”. Organic technologies such as bone, antler, and ivory were incorporated into the Clovis techno-complex by forms including socketed fore-shafts, beveled bone rods, awls, needles, billets, atlatl hooks, points, and abstract symbolic ornamentation (Bradley et al. 2010; Waters et al. 2011; Wilke et al. 1991). However, organic tools credited to Clovis culture are surprisingly lacking. Bradley et al. (2010) suggest the low recovery of organic formal tools results from taphonomic bias and poor preservation. They do, however, suggest these tool-types would have been easily made and readily used by the ease in manufacture and abundance in quantity.
In sum, lithic raw material data demonstrate that long distance lithic transport was an intrinsic feature of Clovis adaptations, a fact that is likely to have imposed specific constraints on their technological decision making.

**Clovis Biface Technology and Projectile Point Production**

Bradley et al. (2010:1) introduce the Clovis techno-complex by stating “Clovis as an archaeological culture describes a range of materials and behaviors found throughout sub-glacial North America extending down to northern South America…” However, many of these sites are restricted to the plains region of North America (Bradley 1993). This region also may explain why most Clovis sites are associated with mammoth, bison, and pronghorn (Haynes 1993; Frison 1993). Other faunal resources may have included smaller game species, but these data are limited (Waguespack and Surovell 2003). The success of the Great Plains Clovis hunters on such large dangerous prey with heavy hides and muscle is mostly credited to the efficacy of their projectile points. In addition to their sharp point and edges, typical Clovis points (Figure 1) were fluted to ease hafting and the basal sections were generally more narrow allowing maximum penetration.
Clovis projectile points were manufactured following a complex reduction strategy (Bradley 1993). The initial procurement of raw material was followed with early stage reduction to produce a general morphology and prepared the bifacial core for future flake removal and tool production. Bradley (1993) argues that during this stage, these bifaces were used mainly as cores for removing large flakes to be used as expedient tools. This process would continue until the bifacial core was thinned to the point where few, if any, large flakes could be removed and with additional flaking was transformed into a Clovis projectile point. Simply put, “Most bifaces in Clovis are either point preforms or flake cores….Flakes are the primary cutting tools in this technology…” (Bradley et al. 2010: 13). This reduction strategy is discussed in much detail below in the Point Production section of this thesis.
The most iconic aspect of the Clovis techno-complex is the highly distinctive projectile points (Stanford 1991). These points were commonly the end result of an extensive bifacial reduction continuum starting with either large chunky flakes or minimally flaked bifacial cores (Collins 1999). In fact, Collins (1999) argues most bifaces served as point preforms rather than finished formalized tools.

Bradley et al. (2010) describe the Clovis point production sequence in detail. Clovis assemblages exhibit two main reduction stages that can be further subdivided into a number of phases. The first stage represents the collection of lithic raw material and the initial shaping, while the second stage comprises all other phases of modifications (Bradley et al. 2010). Clovis point production starts with a large bifacially flaked core (Figure 2). These cores were either broken to be used as two separate cores, or to be used as is. Large flakes were then struck from such cores to be used as expedient flake tools for cutting or scraping. The third phase refers to these large flakes being reworked into bifaces using an *alternating opposed bifacial thinning* technique described by Bradley (1982) as large thinning flakes being removed from the same face, but by alternating the margin from which the flake was detached. This flaking strategy often results in intentional over-shot flakes (i.e., *outrepassé* flakes) that are commonly argued to be a diagnostic feature of Clovis point production (but cf. Eren et al. 2013). Further reduction employed *opposed diving biface thinning* where the flakes terminated along the mid-line of the long axis (Bradley 1982). Both these techniques were used to thin bifaces, while the fourth stage of creating a projectile point includes final edge modification, fluting, and basal grinding.
Huckell (2007) divides Clovis bifaces into two categories: primary bifaces, which are minimally thinned bifaces that were not necessarily intended to become projectile points but could be modified as so when needed; and 2, secondary bifaces which were basically preforms for points. Waters et al. (2011b) expand this classification by dividing Clovis bifaces into four categories: primary; secondary, preforms; and finished points. From that perspective, primary bifaces are thick, retain cortex, and have highly sinuous edges. Secondary bifaces are relatively thinner than primary bifaces, biconvex in cross-section, less sinuous, and have a lanceolate shape with a convex base and round tip (Waters et al. 2011b: 93). Preforms represent the final stage of point manufacture, and display a well-defined lanceolate form; edges are highly regularized and even less sinuous than in secondary bifaces. Preforms also show evidence of pressure flaking and
fluting. Lastly, finished points are identified by retaining many of the traits of preforms, but also exhibiting extensive reworking.

Both descriptions of Clovis bifaces and projectile points indicate that Clovis point manufacture follows a reduction continuum. This continuum begins with a large biface and after achieving the desired thickness for the biface, pressure flaking is used to give it the proper symmetry and morphology required for it to serve as an effective projectile point. Wilke et al. (1991:221) sum it up well when they say “it is likely that biface reduction flakes were first used as cutting tools, then modified by resharpening as needed, and finally made into Clovis points…” Wilke and colleagues also cogently argue that Clovis knappers were extremely careful not to compromise point production even when flake cores became exhausted. This suggests that Clovis projectile points were highly valued implements and that when cores became exhausted, tool makers would adapt manufacture procedures to conserve lithic material, ensuring point production was feasible until a core’s utility was exhausted. The ability to alter manufacturing procedures reflects the high skill level involved in Clovis tool production.

Sellet (2006: 224) describes the manufacturing process of Clovis technology as a complex process that required proper training and great skill, and he concludes that projectile points were difficult to manufacture, due to the high risk of failure during the various phases of manufacture (Bamforth and Bleed 1997). Bamforth and Finlay (2008) further show that the use of intentional over-shot flaking in Clovis bifaces indicates a high level of skill (but see Eren et al. 2013). Along with the reduction sequence, fluting - a Clovis diagnostic feature -- requires specific surface morphology preparation, precise
impact placement, and strong anvil support (Patten, 2002), all of which also indicate the
great skill needed to avoid mistakes during Clovis point production.

The data above consistently describe Clovis point manufacturing beginning with a
biface as seen on typical Clovis points. However the research presented here focuses
toward those points that do not appear to be made by beginning with a biface. These
points on flakes, which will be described in detail later in this chapter, are evidence of a
deliberate adjustment in Clovis point technology.

**Clovis Blade Technology**

The Clovis techno-complex is not only limited to biface and flake stone
technologies, but also includes an important blade and bladelet component that is as
diagnostic as the finely made fluted projectile points associated with Clovis (Sain 2010).
Initially defined by François Bordes as any flake where the length is at least twice that of
the width (Bordes 1961; Collins 1999), this definition was used exclusively when
examining Lower and Middle Paleolithic lithic assemblages, but when considering the
“true blades” of the Upper Paleolithic a more strict definition of blades was needed
specialized flake with parallel (or sub-parallel) lateral edges; length is more than twice
the width; cross-sections that could be plano-convex, triangulate, sub-triangulate,
rectangular, or trapezoidal; with a minimum of one crest following the length of the
blade. Furthermore, Waters et al. (2011) and Bradley et al. (2010) add one additional
definition to blade manufacture that recognizes the importance of a specifically designed
prepared core.
Clovis blade cores were either conical or wedged shaped (Figure 3) (Bradley et al. 2010; Goebel et al. 2008; Waters et al. 2011). Conical (or round) blade cores were used so that platforms were oriented perpendicular to the long axis and blade removal followed the circumference of the platform. With the Gault site as an exception (Collins 1999; Dickens 2005; Waters et al. 2011), wedge-shaped cores occur less frequently, and were less complex than their conical counterparts; but equally important within the Clovis techno-complex (Bradley et al. 2010). An acute angle between the primary platform and the axis of detachment, along with a limited portion of platforms for blade removal, is what separates a wedge-shaped core from a conical core (Goebel et al. 2008). This allows for both unidirectional and multidirectional blade removals from multiple faces emanating from different platforms (Collins and Louse 2004; Jennings et al. 2010).

Figure 3: Stylized illustration of Clovis blade cores (Note A: Conical core; B: Wedge core. Illustrations by author)
Clovis blades (Figure 4) follow the same criterion as the above mentioned “true blades” but also exhibit additional characteristics differentiating them from other blade technologies (Bradley et al. 2010). These attributes include: smaller platforms; straight to exceptionally curved in longitudinal section; smooth ventral faces; noticeably long (length to width ratios commonly exceeding 4:1) with both narrow and robust cross sections; distal terminations commonly converge at distal end of the core resulting with a cone or pyramid core morphology; and margins that are relatively even and exceptionally sharp (Bradley et al. 2010; Collins 1999; Waters et al. 2011b).

Figure 4: Prototypical Clovis blades from the Gault site. Taken from Waters et al. (2011).
As blades were continuously removed from the blade cores, rejuvenation practices were needed to maintain blade-core platform reliability (Bradley et al. 2010; Collins 1999; Waters et al 2011). Bradley et al (2010) and Waters et al. (2011) describe one specific flaking strategy which included the removal of a *core tablet flake* (Figure 5). These flakes removed the entire platform surface of a conical core. This would have created a very smooth and slightly concave surface platform from which additional blades would have been removed. Core tablet flakes generally exhibit large stacks centered in the platform with large step and hinged fractures on the perimeter. Bradley et al (2010) suggest these flakes represent a corrective/maintenance measure implemented by Clovis knappers to extend the vitality of their blade cores.

![Stylized illustrations of a core tablet flake. Illustrations by author.](image)

**Figure 5:** Stylized illustrations of a core tablet flake. Illustrations by author.
Clovis blade technology served as a means to reliably and repeatedly produce flakes with sharp edges (Bradley et al. 2010). In many aspects, un-modified blade edges serving as cutting implements outperform the effectiveness and durability of bifacially retouched edges (Hayden et al. 1996). However, the same can be said for retouched edges (Bradley et al. 2010). The differences and efficacy between the two tool-types reflect the object material being altered. As the evidence demonstrates, Clovis peoples utilized a wide range of resources and having both tool types within their techno-complex reflects their overall resourcefulness and adaptive strategies.

**Clovis Points on Flakes**

Clovis tool-makers did not restrict their point production strategy to only bifacial preforms. A few Clovis points also appear to have been manufactured from early stage core reduction flakes (hereafter referred to as flake blanks) identifiable by the presence of a detachment scar. These points do not display the attributes, or flaking patterns described above. Rather they show a series of pressure flake removals on the dorsal face that are the result of thinning the piece and removing imperfections, as well as light bifacial edge retouch to finalize the morphology of the point which creates the sharp margins. Most diagnostically, they maintain the fairly prominent detachment scar (Figure 6) on their ventral faces which generally also exhibits force ripples that originate from the distal end and radiating along the long axis (Figure 7). This indicates that, in many cases, points on flakes have their tip at the bulb of percussion. This tip orientation minimizes the amount of thinning required since the flake becomes thinner further away from the bulb of percussion. This, in turn, negates the need for fluting on the ventral face, which most of the points on flakes described below in fact lack.

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Figure 6: Clovis point on flake blank from the Eckles site (14JW4) manufactured from Clear Chalcedony.

Clearly, it is not the case that using flake blanks represent one of only two ways to produce a Clovis projectile point; however, the idea that points on flake blanks consistently differ from points on preforms more than simply by maintaining the observable detachment scar is an idea that is amenable to empirical evaluation. For one thing, the presence of these detachment scars could suggest a less extensive life-history (Andrefsky 2009) when compared to points that do not display them by representing a less intensive reduction of the blank on which the point was made. Stone tool life-histories begin with raw material procurement and end with discard, and include all modification in between, from initial shaping, to retouch, and repair. As such, the morphology of a stone implement can reflect its use life, including specific adaptive modifications that reflect behavioral responses to local conditions. Unsurprisingly, lithic life histories drawing on the concept of curation (often measured by the extent of retouch) have been used extensively to understand land-use dynamics and adaptive strategies of foraging cultures in both European (Riel-Salvatore and Barton 2004) and American
archaeology (Andrefsky 2009). From this perspective, rather than to state that point-on-flakes and point-on-preforms reflect mutually exclusive production strategies, I investigate here whether the presence of a detachment flake scar on some points can be taken to reflect a different kind of life history than for those that do not show this feature.

Since the production of Clovis points on preforms relies on an extensive reduction sequence, while points on flakes require a less extensive reduction strategy, the two strategies can reasonably be expected to be associated with different amounts of lithic debris produced. If this can be tied to distinct lithic economizing strategies, the selection of one or the other strategies in certain contexts may reflect an adaptation to the high mobility of Clovis foragers on the Great Plains, where high quality stone deposits are few and far between (Holen 2001).

Figure 7: Clovis point on flake blank Wray Colorado manufactured from Hartville chert. Private Collections.
In the context of the high mobility that appears to characterize a great deal of Clovis assemblages (Kelly and Todd 1988; Sellet 2006; Surovell 2000), lithic conservation would have been important during long-distance travels through areas with few or no known high quality lithic raw material sources. High quality, fine grained stone would have been preferred because it is easier to work, thus increasing reliability in stone tool production (Bleed 1986; Goodyear 1979; Kelly and Todd 1988). Along with a desire to reduce risk of failure during production, maximizing the utility of good raw material nodules suggest that using flakes in projectile point production may be one strategy to decrease the risk among highly mobile foragers. Bradley et al. (2010) also emphasize that Clovis foragers specifically selected higher quality material for tool production, and that it is not uncommon to find in Clovis caches raw materials from many difference sources spread over considerable distances (Huckell et al. 2011). These authors further explain that this raw material procurement strategy reflects a combination of opportunistic and embedded exploitation of various sources encountered during Clovis seasonal rounds (c.f. Brantingham 2003). This supports the notion that mobile groups transported higher quality raw materials over long distances and conserved these materials by maximizing the core’s output by minimizing waste. In fact, the selection of projectile points as the main focus of this strategy reflects Newman’s (1994: 491) statement about the preferred usage of higher quality raw material for their manufacture.
It must also be noted that Collins et al. (2003), Waters et al. (2011b: 130), and Wilke et al. (1999) have previously identified Clovis points on flakes, but that they did not address whether they represented a different point production strategy. Similarly, illustrations have demonstrated points on flakes in Montana (Davis 1993; Figure 8) and South Carolina (Sain 2012; Figure 9). However again, no further insights into these very different points have been presented. Here, it is suggested these points reflect one form of lithic conservation by Clovis foragers. This study thus tackles the question of whether Clovis points on flake blanks can be shown to reflect a technological strategy to maximize the utility of high quality stone in the context of long distance mobility. To do so, both points on flake blanks and on preforms will be compared on the basis of their dimensions and technological features, as well as on distance from raw material source.
Figure 9: Illustration of point on flake blank recovered from the Topper site in South Carolina. Illustration by author.
CHAPTER III
THEORETICAL ORIENTATION: HUMAN BEHAVIORAL ECOLOGY

The research presented in this thesis is founded in *Evolutionary Ecological Theory*, which is defined as “the study of adaptive design in behavior, life history, and morphology” (Bird and O’Connell 2006:143). This framework emphasizes *behavior* as the adaptive means within environmental contexts, which thereby affects overall fitness of the individual or group (Williams 1966). Stemming from ecological research in the 1960’s and 70’s, *behavioral ecology* - a subfield within evolutionary ecology - was initially used to understand social, reproductive, and foraging patterns in non-human organisms and landscape dynamics (e.g. Alexander 1974; Lima and Zollner 1996), but was later adopted by anthropologists and applied to human populations. This application resulted with a new subfield of evolutionary ecology designated Human Behavioral Ecology (HBE) which initially applied optimal foraging models (Cronk 1991) to hunter-gatherer populations (e.g., Waguespack and Surovell 2003). Even though early HBE proponents focused on hunter-gather subsistence based in optimal foraging theory, its fundamental principles provide a transparent methodology to understand additional components of human behavior. Because HBE assumes human behavior is subject to natural selection (Surovell 2009), adaptive behaviors should be transmitted culturally and the capacity for optimizing behavior transmitted genetically. Even though the relationships between genes and behavior as a one-to-one association have not been easily demonstrated, it is widely accepted that behavior, in the general sense, is “ultimately the product of the interaction of myriads of genes” (Surovell 2009:7). From
this perspective, behavior therefore represents a problem-solving effort to maximize benefits or minimize costs.

HBE approaches commonly utilize mathematical modeling to provide a reductionist framework within which to derive testable hypotheses which can then be confronted against the record. These hypotheses emphasize simplicity instead of a more complex holistic approach seen in the particularistic tradition of cultural anthropology (Winterhalder and Smith 2000). These simple models indicate what expected behavior should be within a general context or environment. To do so, these models therefore must define the goal and decision variables, and within them, the goal reflects the intent of the behavior in terms of a specific currency (e.g., calories), while the decision variable represents what behavioral aspects will be adjusted to meet this goal (Surovell 2009). Empirical data are then tested to determine if these expected behaviors are actually in practice or whether the actual behavior deviates from its hypothesized fitness-maximizing predicted state (e.g. Bird 1997). Both possibilities are equally important because it allows for re-examination of social or environmental factors for causation when initial hypotheses are falsified.

Archaeological application of HBE is grounded on the proposition that behavioral diversity is socio-ecologically specific, which therefore requires understanding the circumstantial landscape that motivates individual fitness (Bird and O’Connell 2006). Specifically, HBE favors the advantageous behaviors that increase adaptive fitness within a given context. The application of HBE to lithic assemblages stems from defining technological organization as “the selection and integration of strategies for making, using, transporting, and discarding tools and the materials needed for their manufacture
and maintenance” (Nelson 1991: 57). With this definition, HBE models are well suited for testing lithic assemblages because decisions were made throughout their use-life which probably reflected optimizing concerns by the individuals involved (Surovell 2009).

From this perspective, it does not matter if the behavior is learned or instinctive, biological or cultural in origin. In fact, Bamforth and Bleed (1997) review archaeological research as focusing on ways artifacts and/or behavioral patterns likely enhance fitness within certain environmental contexts and, more importantly, the effects of these alterations of either technology or behavior within given contexts. They further discuss how this scope of analysis purposefully avoids individual reproductive fitness. The deliberate dodging of individual fitness following Darwinian evolution allows researchers to focus more on group selection processes (e.g. Kaplan and Hill 1985) which may be better suited for understanding cultural change from the archaeological record (Bamforth and Bleed 1997). This debate between individual and group selection acted as one of the drivers of the development of behavioral ecological theory (Cronk 1991: 27.) This debate started when Wynne-Edwards (1962) argued natural selection in human populations occurred at the group level (see also Hamilton 1964; MacArthur and Pianka 1966). This was rebutted by Lack (1966) and Hamilton (1964) who picked apart Wynne-Edwards’ interpretation and determined, on both empirical and theoretical grounds, his data most parsimoniously reflect individual selection. To date, the dispute between group and individual selection is still ongoing; however, most HBE proponents agree that selection has the potential to act on multiple levels, most likely beginning at the individual level (Cronk 1991). Understanding individual selection through the
archaeological record is very difficult, however. Archaeological sites represent palimpsests of past group behavior over extended periods of time, and distinguishing specific variations that might have promoted individual reproductive fitness is quite problematic (Bamforth and Bleed 1997).

Using these simplified models, which generally evaluate cost/benefit considerations resulting from specific behavioral choices, archaeologists have begun to move away from subsistence practices and began focusing on the lithic technologies (see Bamforth and Bleed 1997 for discussion). Studies concerning raw material acquisition and exploitation, tool morphology, degree of retouch, and discard patterns made good use of the HBE hypothetico-deductive reasoning strategy (Winterhalder and Smith 2000) which later produced formal models to understand tool-kit composition in mobile foragers (Bird and O’Connell 2006; Kuhn 1994).

Within the HBE framework, understanding tool-kit composition is done by considering technology as the basis for manipulating the physical environment (Bamforth and Bleed 1997) and by seeing any variation within this system representing behavioral adaptation to the local environmental. If we accept Clovis culture comprised highly mobile big-game hunters, it can be expected that hunting weaponry had high economic value. Furthermore, distance between raw material sources would have acted as an environmental stress which would need behavioral modification to maintain baseline amounts of lithic utility while away from sources. These parameters produce the hypothetical reasoning needed to deduce an adaptive behavior in Clovis foragers. The behavior under investigation here is the use of primary flakes or informal flakes tools over the preconceived use of bifacially reduced preforms, to manufacture a projectile
point. This represents the decision variable described above, with the goal being lithic conservation and/or maintaining lithic utility when raw material availability is limited.
CHAPTER IV

ANALYSIS OF POINTS ON FLAKES

The research question investigated here assumed that Clovis foragers were highly mobile and traveled considerable distances; their point production strategy followed a predictable reduction sequence that started with large bifaces; and that projectile points held high economic value. These assumptions support the hypothesis that distance from lithic source would have acted as an environmental stress. The increase of distance enables a proxy to measure re-tooling events required. As more re-tooling events would have occurred, changes in tool maintenance and production strategies might reasonably have acted as a risk-reduction mechanism to ensure usable stone was available to Clovis foragers. Thus, the idea to be tested in this study is whether points maintaining a detachment flake-scar represent a behavioral strategy to ensure lithic utility and serve as a means to conserve transported tool-stone. This is supported if these points can be shown to occur more frequently further from raw material sources as it would demonstrate an alternative point manufacture procedure beginning with a primary flake or an informal flake-tool rather than a bifacial preform—to maximize lithic utility in an environment where high-quality lithic sources are rare. This behavior could therefore reflect a behavioral effort to minimize the cost of typical point production processes described by Bradley et al. (2010) and Waters et al. (2011b).

Methods

A sample (n=244) of Clovis projectile points and preforms from the central Great Plains (Colorado, Kansas, and Nebraska) is used in this study. This sample is the same as
that used by Holen (2001) to conclude that Clovis lithic procurement and mobility patterns in that region reflect a long distance migration, most likely following faunal resources. This sample includes points from private and museum collections and identification was done by Steven Holen and Jack Hoffman, both of the University of Kansas. The recording of points included travel throughout the central Great Plains to both museums and private collectors and morphological attributes were measured using digital calipers. Source identification was done through macroscopic observation and both microscopic and UV luminescence testing (Holen 2001). For private collections, recovery location could usually only be narrowed down to the county level although this introduces only a marginal degree of imprecision given the large scale of most distance under consideration.

The raw-material sources encountered throughout the sample region include many high-quality sources (e.g. Knife River Flint, Edwards Chert, Smokey Hill Jasper, etc.) with fewer medium to lower quality sources (e.g. silicified wood, quartzite, etc.). Even though high-quality sources were available, quarries were limited to specific regions. Most of these quarry sites are macroscopically diverse allowing for easier sourcing practices within the Great Plains. This beneficial practice allows for precise lithic sourcing and accurate measurements for distance travel by lithic materials. For instance, a common raw-material found in Clovis assemblages includes Edwards Chert, which originates in central Texas but is consistently recovered in sites from northern Colorado, Nebraska, and Wyoming. This distance between Edwards Chert quarries and recovery sites sometimes exceeds 900km. Knife River Flint outcrops occur in North Dakota and points made on this material are recovered in southern Kansas and Colorado. Smokey
Hill Jasper and Hartville Chert (also known as Hartville-Uplift Chert) source to northern Colorado and southeastern Wyoming. These high-quality sources are recovered throughout the central Great Plains and as far east as Missouri. This is also the case with Clear Chalcedony, which occurs in the front range of Colorado and recovered in eastern Kansas some 625km away.

Because raw material (see Hoard et al. 1992 and Holen 2001 for more detailed descriptions) and distance from source are the main variables considered in this study, any artifact missing information about either was excluded from consideration here. The resulting sample (n=117) consists of 104 points on preforms and 13 points on flake blanks (see Appendix 1), both of which are represented by complete and partial points. Although this may unwittingly create a bias towards points on preforms due to point fragments not preserving the detachment scar on their ventral surface, removing all partial points would have further reduced the sample of point on flake blanks to a total of only 10. Thus, blank type was identified on the basis of the presence or absence of a recognizable detachment scar for all artifacts, under the reasoning that mistakenly including fragments of points on flake blanks in the ‘preform’ sample would lead to the preferable outcome of falsifying the hypothesis that the two point types can be differentiated, a false negative, which is logically preferable to identifying a false positive trend that they are clearly distinguishable.

The significance of differences in dimensions (i.e., length width, thickness, per Holen 2001) between the two point types were tested at the 95% confidence interval ($p \leq .05$) using PASW v.22 software. The tests include both parametric and non-parametric due to the comparatively small sample of flake blank points. The parametric tests used in
this study include the independent variable t-test and a one-way ANOVA, while the
Mann-Whitney U statistic was used for the non-parametric test.

Morphological data were tested to determine if blank type affected overall point
dimensions. If points on preforms reflect a more extensive life-history, then
morphological dimensions might be expected to reflect this and to differentiate them
from points on flakes. It would be expected that smaller points with more extensive
retouch would be recovered further from lithic sources. The diminished size results from
either extensive retouch through constant re-sharpening or from recycling broken point
fragments into usable hunting points. However, length tends to be the most inconsistent
dimension in recovered points; whereas width and thickness tend to follow a consistent
4:1 (w/th) ratio in finished points (Bradley et al. 2010). To ensure reliable morphological
testing, the sample first excludes partial points, resulting in a measured sub-sample of ten
points on flakes and 59 points on preforms, but then includes these points and compares
the results between both series of tests.

Results

Table 3 summarizes the results of these statistical analyses on the relationship
between blank type and distance from source, length, width, and thickness values. The
most significant difference between the two blank types are distance-from-source
(p=.007) and thickness (p=.007). As concerns distance-from-source, Figure 10 clearly
shows that the majority of points on preforms occur between 75 and 300 km from source,
whereas points on flakes mostly are found between 200 and 600 km from source.
Additionally, almost 60% of points on preforms are found within 200km of the source
and occur in ever decreasing frequencies after this point (Figure 11). This is in marked
contrast to points on flakes; more than 66% of which are found more than 200km from source. It thus appears that as distance from source increases, the likelihood of point manufacture beginning with a less-curated blank also increases as shown by the greater proportion of points maintaining a visible detachment flake scar (Figure 12).

Table 2: Results from statistical testing of sample

<table>
<thead>
<tr>
<th>Distance from source (km)</th>
<th>Detachment Scar</th>
<th>N</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Significance (p ≤ .05)</th>
<th>t-score</th>
<th>F-score</th>
<th>Degrees of Freedom</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Present (0)</td>
<td>13</td>
<td>414.4</td>
<td>302.6</td>
<td>0.007*/.017**</td>
<td>2.72</td>
<td>7.4</td>
<td>115</td>
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<tr>
<td></td>
<td>Absent (1)</td>
<td>104</td>
<td>236.8</td>
<td>210</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Detachment Scar</th>
<th>N</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Significance (p ≤ .05)</th>
<th>t-score</th>
<th>F-score</th>
<th>Degrees of Freedom</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Present (0)</td>
<td>10</td>
<td>5.6</td>
<td>1.3</td>
<td>0.174*/.24**</td>
<td>-1.373</td>
<td>1.885</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Absent (1)</td>
<td>59</td>
<td>6.6</td>
<td>2.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Width</th>
<th>Detachment Scar</th>
<th>N</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Significance (p ≤ .05)</th>
<th>t-score</th>
<th>F-score</th>
<th>Degrees of Freedom</th>
</tr>
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<tbody>
<tr>
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<td>0.7</td>
<td>0.913*/.627**</td>
<td>-1.1</td>
<td>0.012</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Absent (1)</td>
<td>59</td>
<td>2.7</td>
<td>0.6</td>
<td></td>
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<th>Thickness</th>
<th>Detachment Scar</th>
<th>N</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Significance (p ≤ .05)</th>
<th>t-score</th>
<th>F-score</th>
<th>Degrees of Freedom</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Present (0)</td>
<td>10</td>
<td>0.62</td>
<td>0.14</td>
<td>0.007*/.021**</td>
<td>-2.765</td>
<td>6.189</td>
<td>67</td>
<td></td>
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<tr>
<td></td>
<td>Absent (1)</td>
<td>59</td>
<td>0.74</td>
<td>0.13</td>
<td></td>
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Turning to metric dimensions, thickness appears to be the only attribute that discriminates between the two kinds of points (p=.007), while length and width fail to do so (Table 2). The separation based on thickness almost certainly refers to the fact that

Figure 10: Distribution of blank types in relation to distance from source.
Figure 11: Distribution of blank types from source

Figure 12: Relative frequency of blank types within distance categories
Figure 13: Dimensional comparison between blank types
Figure 14: Dimensional data between blank types in relation to distance. Complete points only.
flakes do not need to be thinned on their ventral surface, making points on this blank type inherently thinner overall than those on preforms. Although length and width data do not show statistically significant differences between the two point types, when displayed graphically, it can be seen that points on flakes are as a whole relatively smaller than their preform counterparts (Figure 13); albeit not significantly.

When comparing the dimensional data between blank types in relation to distance from lithic source, an intriguing pattern emerges. Figure 14 shows a slight increase in the size of points on preforms as distance increases—especially after 150km. Similarly, all dimensions of points on flake blanks decrease as distance increases up to about 250km, after which they begin to increase in size as distance also increases. However, any interpretation of points on flakes and their relationship between distance and dimensions is limited by the sample size. In order to flesh out any possible relationship, a larger sample would be needed. This, however, is possible with the points on preforms sample used above. Figure 15 displays the same pattern described above pertaining to complete preform points only.

ANOVA testing on complete points-on-preforms was used to determine if there is a significant relationship between distance categories and point dimensions. Testing revealed no statistically significant relationship (p=.2783 for length; p=.1359 for width; p=.1397 for thickness) between point dimensions and distance. This result may be an artifact of the limited sample used, however, and future assemblages with similar
Figure 15: Comparison of dimensions between distance categories.

NOTE: All measurements in cm.
data records might help establish the significance of these patterns, which will be discussed further in Chapter 5.

The evidence indicating that points maintaining a detachment flake scar are relatively smaller than points on preforms supports the above hypothesis whereby points on flakes may represent a conservation effort by Clovis tool-makers seeking to maximize lithic utility. These conservation efforts would have been favored when transporting raw material over considerable distances through regions lacking high-quality material. These efforts were more likely in response to the point production cost of bifacial reduction techniques observed in typical Clovis points.

Overall, the results presented here indicate that there is a statistically significant difference \((p=.007)\) between blank types in relation to distance from the source. Furthermore, the only morphological variable that is also statistically different is thickness \((p=.007)\). However, a visual inspection of the data (Figure 12) also reveals that points maintaining a detachment scar occur more frequently further from lithic sources, and that these points also tend to be smaller and thinner than those that do not. A likely interpretation of these trends is that they reflect a conscious effort by Clovis foragers to minimize the cost of point production and to maximize the overall output of transported raw material. These risk-mitigating behaviors would have been essential in Great Plains Clovis peoples who occupied a vast geographic area with few distantly situated high-quality raw material quarries.
CHAPTER V

CONCLUSION

A sample of Clovis projectile points included several points maintaining the ventral surface from flake detachment. These points, while rare, do not reflect the preconceived manufacture sequence described by Bradley et al. (2010) and Waters et al. (2011b). It was hypothesized here that these uncommon points reflect an alternative point production sequence that begins not with a bifacially reduced preform, but rather a primary flake or by converting an informal flake tool into a viable hunting point. This effort would alleviate the problem of tool stone depletion while traversing long distances through the central Great Plains. These conscious behaviors would have been favored in this region where high-quality lithic sources are few and far between (Bamforth 2009; Holen 2001).

Similar observations have been discussed elsewhere, but pertaining towards post-Clovis cultures (e.g. Folsom and Midland). Holfman et al. (1990) describes in detail the Shifting Sands site’s Folsom and Midland artifacts recovered from western Texas. Here, they argue the use of bifacial preforms and flake blanks are recovered and common within both Folsom and Midland assemblages and the use of alternative preform types probably reflects available raw material quantities and functional demands, such as reworking a unifacial tool into an expedient projectile point (Hofman et al. 1990). Furthermore, these authors imply the use of flake blanks is not strictly reflective of increasing distances from source, but rather reflecting the number of kill-butchery and retooling events occurring after the initial procurement event. I simply argue here that Folsom and Midland toolmakers were not the first to make these considerations, and how
using distance from source can be used as the proxy to measure an increase in retooling events.

Reverting back to the Clovis sample, points on the two blank types show clear and statistically significant differences in their distribution relative to raw material sources that are also accompanied by some differences in point dimensions. When these data are combined, it becomes clear that points on flake blanks occur at further distances proportionally and that they fall towards the smaller end of the range seen in recovered Clovis points. Points-on-flakes tend to be smaller than their preform counterparts and with less retouch, meaning that points on flake-blanks require less stone than points-on-preforms. This can therefore be interpreted in two ways. Firstly, points-on-flakes could represent evidence of depleted raw material which was no longer sufficiently available to produce larger blanks. Secondly, these points could reflect a conscious decision to minimize the cost of extensive thinning. The cost of thinning a preform includes the risk of breaking the blank during manufacture. The choice to use a flake (which would require less retouch and thinning) may in fact be the behavioral adaptation for optimizing and extending the utility of transported raw material. Simply put, why risk wasting high-quality materials through a more extensive and involved point production strategy, when using a flake reduces the risk associated with bifacial thinning and extends the utility of available raw material by beginning with a smaller blank?

It would be expected that, as distance increased, recovered points should be smaller and more curated than those recovered closer to the lithic sources. However that is not always the case. As demonstrated in Chapter IV, there is a decrease in point size initially, but an increase in size beyond a certain point. For points on preforms, this
A decrease was observed to a distance of around 150km. Past 150 km, there is a slight and gradual increase in point size. In contrast, points on flakes blanks decreased in size up to about 240km from source, after which they also begin increasing in size. It must be stressed, however, that these trends do not appear to be statistically significant and if there is no difference between discarded projectile points as distance increases, then most recovered points likely simply reflect the dimensional size at which Clovis peoples would discard projectile points.

According to Bamforth (2009), long distance lithic transport is not necessarily the result of one group traversing such distances, but can rather represents trade networks between two neighboring groups each occupying much smaller regions. He suggests that points and point preforms were exchanged by using the evidence of exotic raw-material—generally used for these tool forms—being recovered at such extreme distances from their locality. In contrast, informal tool types seem to be made overwhelmingly on more local, lower quality raw materials (Bamforth 2009). With this in mind, it could be postulated that a group anticipating an exchange of tool-stone would reserve some material for this event (see also Whallon 2006). Evidence to support this argument may lie with these larger points being recovered at longer distances, though additional research on larger datasets is needed to establish this unambiguously.

Overall, these data indicate that projectile points on flakes may therefore well represent a technological adaptation to conserving lithic raw material in the context of long distance lithic transport (Holen 2004, 2001). If lithic sources were scarce or unknown, Clovis knappers needed to make sure they had stone available even if they
could not provision it anew, which means that there would have been a premium on maximizing the utility that could be derived from given volumes of raw material.

According to Bamforth and Becker (2000), Paleoindians favored the use of bifacial cores for transport. These cores could both act as simple chopping tools, or have flakes struck off them to provide expedient tools. If these cores were created close to the lithic source and transported over considerable distances, the further the core is from the source, the greater the reduction in core volume and in turn in the size of useable flakes able to be removed from these cores. This adheres to Newman’s (1994) observation that flake size decreases as distance from source increases. While Bamforth and Becker (2000) mostly focus on Folsom, their discussion is relevant to Clovis points on flakes because Bradley et al. (2010) and Waters et al. (2011) suggest that the Clovis point reduction sequence began by removing large flakes from bifacial cores. These flakes were initially used as expedient tools, and were then reworked and thinned before being turned into points. As core utility decreased as they were reduced over the course of their users’ travels, the appeal of using small flakes as blanks for points increases, as this strategy results in less wasting of prized raw material (Bamforth 2003). Incorporating a flake-based point manufacture sequence that maximizes a core’s use-life by increasing the potential output of expedient flakes would help conserve lithic material. Alternatively, large flakes could also be procured directly from quarries with the intent of using them as projectile point blanks. This is a less likely option, however, since flakes have higher transport costs than bifaces (cf. Kuhn 1994; Morrow 1996), in keeping with claims that Clovis tool kits were designed to be easily maintainable, multifunctional, and recyclable, and that bifacial cores embody such technological flexibility (Bleed 1986;
Bamforth 2003). The small dimensions of the present sample of projectile points maintaining a detachment flake scar suggest they were made on flakes struck from heavily reduced cores, maybe as one strategy to conserve high quality lithic material.

That said, it is also likely that Clovis tool-makers made points on primary flakes that lost their visible detachment flake scar as a result of extensive retouch. This, in fact, would be in keeping with suggestions that Clovis tool-kits are designed to undergo a systematic rejuvenation between tool types through reduction (Bamforth 2003; Bradley et al. 2010; Jennings et al. 2010; Waters et al. 2011). For instance, a flake may be used initially for cutting/butchering, but as the edge becomes dull retouch is needed for rejuvenation. This process continues until the flake is discarded or a more extensive modification is employed to convert the cutting tool into a different tool type altogether. The fact that some points on flakes may not be recognizable as such, however, does not disagree with the results presented in this study, since the dimensions of some points considered here to have been made on preforms overlap with those of the subsample of recognizable points on flakes, which in general fall on the smaller end of the size grade from fully retouched points (Figure 13).

Points on flakes therefore can be seen as supporting Wilke. et al.’s (1991) argument about Clovis knappers saving and using flakes as blanks for points instead of trying to reshape exhausted cores into preforms as distance from lithic sources increase. This allowed these cores to continue being used to produce additional expedient tools. This dynamic knapping ability is the source of the apparent contradiction at the heart of this study, namely that seemingly minimally retouched points on flakes occur more frequently as one moves away from the material on which they are made whereas their
superficially more curated counterparts on preforms mostly occur closer to lithic sources. In reality, the more expedient appearance of most points on flakes seems to be tightly linked to raw material conservation strategies.

Using flakes to create points would have been a good alternative in those contexts when reducing a bifacial core into a projectile point would have prevented the production of additional tool blanks. With increasing distance from raw material sources, Clovis knappers came to rely on a flexible point-production process to maximize both core output and maintainability. Using primary flakes instead of reduced bifacial cores as point blanks does both.

Even though projectile points represent a very small fraction of the overall lithic assemblages made and used by Clovis foragers, this study shows how they can nonetheless shine important light on their raw material management strategies. Furthermore, that a small subset of Clovis points does not reflect the ‘typical’ point production reduction reconstructed from cached assemblages clearly shows that these foragers could – and did – tailor their point production strategies according to numerous variables, including the need to maximize the utility of fine-grained stone over long-distance movements. Overall, points on flakes are statistically similar in dimensions to small points on preforms, differing systematically from them only by being thinner. In contrast, the proportion of points-on-flakes increases with growing distance from source. These joint trends are best explained as the results of a coherent alternative manner of producing Clovis points when the standard point manufacture process could not be used because of depleted raw material reserves.
Although there are two distinct Clovis point production strategies, points on flakes are proportionally much more frequent when distance from sources is great, presumably also when cores have been exhausted to the point that larger flakes can no longer be produced. This fits the current understanding of Clovis technology (Bradley et al. 2010; Waters et al. 2011b) and can be interpreted as reflecting a technological adaption for long distance lithic transport.

In sum, then, Clovis knappers did not limit their point production processes to the standard thinning sequence described above, but tailored their knapping skills to maximize core usability and to ensure that points could be manufactured even when raw material had become scarce or only available in small packages. The production of Clovis points on flakes thus appears to be a response to economically using exhausted bifacial cores on high quality stone types from distant sources. This is evident when smaller, less extensively retouched projectile points on flakes are recovered further from lithic sources than their larger, more extensively retouched preform counterparts. This is suggestive of a technologically adaptive last ditch effort to maximize lithic utility when resources were scarce. These points thereby reflect an effort to maximize scarce resources and an adaptation to a highly mobile lifeway.

Clovis points on flakes thus reflect the technological innovation needed by Clovis tool-makers to reduce the risk of uncertainty while traveling through the Great Plains in North America. These hunters occupied a region where few high quality raw material sources were available and the distance between quarry locations exceeded hundreds of kilometers. Instead of inflexibly following an elaborate and relatively wasteful point production sequence beginning with larger flakes reworked into bifacial preforms, Clovis
knappers also in some contexts utilized smaller flakes for point production. This hypothesis is supported by the significant relationship between blank type and their statistical means between distances from raw material source. Over two-thirds of Clovis points without the detachment flake scar occur within two hundred kilometers of raw material source, whereas over two-thirds of points with a detachment flake scar occur past two hundred kilometers. Furthermore, as the distance from source increases, the relative proportion of projectile points with these scars also increases.

The overall differences in dimensions between blanks remain insignificant. However, when graphically displayed, it can be readily seen that points on flake blanks tend in fact to be smaller insignificantly. The only significant metric difference is seen in thickness between blank types. This can be easily understood when considering flake blanks would require less thinning than bifaces, especially on their ventral face. Many of the flake scars present on the ventral face of points on flakes represent marginal flaking to give the point the typical Clovis morphology and cutting edge.

Points on flakes represent an alternative point production strategy not currently discussed in Clovis research. The original hypothesis tested in this study questioned the context of points maintaining a detachment flake scar and their relationship within Clovis assemblages. It was argued here that these rare and distinctive points reflect an alternative point production process aimed at conserving high quality raw materials. This conservation effort may have stemmed from the common practice of transporting lithic materials over distances in excess of 900km seen in Great Plains Clovis peoples.

As Chapter II describes, Clovis people are generally considered to have practiced high residential mobility (Kelly and Todd 1988; Surovell 2000). It is common for Clovis
assemblages to contain lithic material from several exotic sources. These materials were of high quality raw materials, something favored by Clovis knappers. The need of high quality material reflects the highly technical and risky point manufacture process observed through experimental and refitting studies of Clovis projectile points (Bradley et al. 2010). This process begins with large bifacial core that were either used to remove large flakes for informal tools, or they were used until no longer able to produce these large flakes; at which point they were reworked into a hunting point. However, bifacial technology was not the only means to produce usable flakes. Clovis also practiced a highly developed blade technology. Clovis blades were longer than those of most other techno-complexes that used this technology. Both technologies reflect the overall resourcefulness and adaptive behaviors practiced by Clovis foragers.

Chapter II also introduces points maintaining a detachment flake scar. These points do not reflect the current model of point production. Even though they are labeled elsewhere, no current research—to my knowledge—has aimed to explain these points. Because these points are a behavioral response to external factors, along with other lithic technologies, Human Behavioral Ecology (HBE) provides a framework within which these points can be understood and ultimately analyzed empirically.

HBE, and its application towards lithic assemblages, is discussed in Chapter III. HBE approaches the archaeological record through the lens of evolutionary theory. With this, behavior can be seen as an adaptive response to environmental stimuli that inherently promotes fitness. For instance, a more effective hunting tool can increase a hunter’s caloric intake, in turn increasing their overall health and reproductive fitness. The method of manufacture and/or implementation of such a hunting tool would be
passed on to later generations or until an alternative hunting/gathering behavior was adopted.

These concepts are applied to the sample of Clovis points in the central Great Plains region of North American described in Chapter IV. This sample was analyzed statistically and strongly demonstrates a relationship regarding points on flakes and their respective distance from source. It was shown that a majority of points maintaining their detachment scar are recovered beyond 200km, whereas the bulk of points on preforms are within 200km from source. Furthermore, these points on flakes are thinner than their preform counterparts. These data, when compiled together, paint a picture suggesting these points on flakes are an alternative point production product designed to mitigate the wasting of material through an extensive bifacial reduction process. This alternative strategy would have been favored in the environmental context to which these Clovis foragers occupied. The central Great Plains has limited high quality raw material, and these quarries are few and far between (Bamforth 2009; Holen 2001). A point production strategy that conserves lithic material in these environmental conditions would have been both adaptive and favored.

This thesis set out to see if these points reflect an alternative point production process, or rather just a meaningless aspect of the Clovis techno-complex. It was established here that these points do in fact represent the technological adaptation of long distance lithic transport practiced by Clovis foragers in some facet of their lithic technology. Future research, that includes larger datasets such that as the Paleoindian Database of the Americas (PIDBA), could be used to test the above hypotheses against other regional and Paleoindian techno-complexes.
Technology in past cultures was not lethargic. It was responsive, adaptive, and dynamic. This applies to the stone tools of Clovis Paleoindians occupying the central Great Plains. In this specific environmental context, tool stone was rare but also highly prized. This would have created the need, or goal, to conserve transported raw material; especially considering the vast distances covered. A potential method for conserving these materials could be to alter the point production sequence that produces higher volumes of waste debitage. This goal-oriented behavioral adaptation reflects the decision variable of whether using a smaller flake that requires less work over a preform that needed more work, was more risky, and more wasteful. This conscious effort to minimize the cost of point production in certain contexts or to maximize the output of transported material reflects the aim set forth by HBE frameworks. As assemblages grow and variations are observed, HBE can provide the framework needed to empirically address these observations; and hopefully reveal past people for who they were and how they lived.
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## Appendix 1: Clovis point sample from the Central Great Plains

<table>
<thead>
<tr>
<th>Lithic material</th>
<th>Distance from source (km)</th>
<th>Blank type (0=flake;1=preform)</th>
<th>Portion</th>
<th>Length (cm)</th>
<th>Width (cm)</th>
<th>Thickness (cm)</th>
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