3D Morphometric Analysis of Late Paleoindigenous Projectile Points from the Mackenzie I Site, Northwestern Ontario, and surrounding regions

Dave Norris, The University of Western Ontario

Supervisor: Ellis, Christopher J., The University of Western Ontario

A thesis submitted in partial fulfillment of the requirements for the Doctor of Philosophy degree in Anthropology

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Abstract

Despite decades of archaeological investigations into the presence of people in northwestern Ontario during the late Pleistocene and early Holocene there is still a tenuous understanding of the timing and origins of those past groups that moved across the region. This is mainly a result of small sample sizes, acidic soils (that degrade organic materials) and low recoveries of diagnostic tools such as projectile points. The discovery of an uncharacteristically large Paleoindigenous site, the Mackenzie I site, east of Thunder Bay, yielded recoveries of artifacts in numbers never seen in the region. The exceptionally large number of projectile points recovered from this site offers a unique opportunity to examine Paleoindigenous activity. Projectile points are considered to contain a significant amount of cultural information in their shape, and in the method of manufacture used for shaping them, largely because they are the most “complex” of stone tools recovered. The recoveries from the Mackenzie I site allow for an in-depth analysis both from an intra-site perspective, as well as a comparison from an inter-region perspective using samples from Manitoba, Minnesota and across northwestern Ontario. In conjunction with a GIS density analysis to identify spatial clusters across the site, a 3-dimensional geometric morphometric (3DGM) examination of the morphological traits of the projectile points is completed. The resulting information offers insight in both how the site was used over time as well as highlighting stylistic variability between the identified areas of the site. Furthermore, part of the 3DGM results from the inter-region comparison indicate that shape variation from the Mackenzie I site is markedly different from all other samples, representing a restricted range of variation suggesting the site was occupied for a brief period of time. These findings contradict previous research, specifically for Minong beach sites, that suggested morphological variation within the region was continuous and multimodal, with attributes varying widely from site to site. Furthermore, additional impressionistic and typological analysis suggests that there is a close relationship stylistically between the points from the Mackenzie I site and western forms such as Jimmy Allen or possibly Angostura. This type of research has never been completed within the region and offers a glimpse into the activities and occupation of the largest Paleoindigenous site in northwestern Ontario.
Keywords

Paleoindigenous, Paleoindian, Thunder Bay, Geometric Morphometrics, Northwestern Ontario, GIS, stone artifacts, Angostura, Jimmy Allen, Archaeology
Summary for Lay Audience

This research compares spearpoints from recoveries of a large Paleoindigenous archaeological site, the Mackenzie I site, east of Thunder Bay. Spearpoints are unique and important because archaeologists have been able to determine where and when they were manufactured based on their shape. The Mackenzie I site is important because it is one of the largest sites excavated in the region with an extremely large number of spearpoints. Having a large site, with many samples allows for a comparison of all the points and their shape. This research compared all the points to highlight those that were like those that were different. Using the rest of the artifacts, analysis was completed to find discrete areas at the site that represented either areas of activity, or areas of occupation using computational Geographic Information’s Systems (GIS) tools such as Point density and Kernel density. The data from the shape analysis and the density analysis, the identified areas (cluster areas) are examined to illustrate the similarities and differences with regards to the spearpoints (ie., those areas with similar points to other areas which had different points). This allows for comment on the different areas and possible groups who used the site over time.

Finally, the overall shape of the spearpoints from the Mackenzie I site are compared to spearpoints from areas in western Manitoba, northern Minnesota and across the rest of Northwestern Ontario. The similarities and differences are explored to comment on where people might have migrated from when Northwestern Ontario was first deglaciated roughly 9500 years ago.
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Any errors retained are solely my fault.

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Appendix A - Photographs of Projectile Points.
Chapter 1

1 Introduction

This thesis provides new insights into understanding the variability within regional Late Paleoindigenous stone projectile point/weapon tip assemblages from northwestern Ontario and adjacent areas. The primary focus is on the analysis of an uncharacteristically large point assemblage recovered from the Mackenzie I site (DdJf-9), located east of Thunder Bay, Ontario (Figure 1-1) using both Geographic System (GIS) tools in conjunction with a 3D geometric morphometric approach (3D GM).

1.1 Context and Significance

Speculation regarding the age and geographic origins of groups who moved into the recently deglaciated northwestern Ontario during the Late Pleistocene to early Holocene have been ongoing since the early 1950s (MacNeish 1952; Dawson 1983; Hinshelwood 1990, 1993; Julig 1984, 1988, 1994; Julig et al. 1990; Ross 1977, 1995). Indeed, MacNeish (1952) initiated studies in Canada of these early peoples when he carried out fieldwork at the Brohm site (DdJe-1) east of Thunder Bay (Figure 1-1). These earliest known groups have been referred to by archaeologists as “Late Paleoindian” and followed “Early Paleoindian” groups such as Clovis and Folsom who manufactured large, lanceolate, “fluted” spearpoints in the hunting of larger, often now extinct, game. In a similar manner, these later groups produced large, lanceolate, or sometimes slightly stemmed, stone, projectile weapon tips, often referred to as “Plano” points. Many types or styles of these later points have been recognized over wider areas of North America and notably to the south in the western Great Lakes and to the southwest on the Plains and adjacent areas. These are dated between roughly 12,000 to 9000 calendar calibrated years (cal BP) (Kornfeld et al. 2010; Meltzer 2009; Wood 1998).

The segregation of Ontario’s earliest pre-contact history (and much of the previous archaeological literature across North America) includes the term “Paleoindian” which is a non-Indigenous label. Indigenous views suggest that they are and were all one people and that this viewpoint is important in the understanding of their social, economic, and
political reproduction (Harris 2005; Hazell 2019; Million 2005; Nicholas 2005). The label “Paleoindian” was meant to designate the first/earliest recognized peoples who migrated into the areas of North America. The culturally laden term “Indian” is a racialized term that has been imposed on a group of people by those who colonized their lands (Hinshelwood 2019:10). It falsely allows archaeologists to believe that they are being objective when it is used (Hinshelwood 2019:10). More recently, indigenous scholars have suggested replacing such terminology (e.g. Steeves 2021; Yellowhorn 2003) and archaeologists have begun to follow this lead (Pitblado 2021). Therefore, to decolonize the use of such terminology and adhere to a more culturally appropriate means of identifying those ancestors whose material culture we study, the term “Paleoindigenous” will be used throughout the rest of this document. The term “Paleo” can be defined as meaning “early” or “ancient” and in this case the discussion revolves around initial peopling of the area, while “Indigenous” is a term meaning original inhabitants of the land.

Paleoindigenous research has considerable potential to understand many general aspects of hunter-gatherer life of interest to anthropologists. Areas of relevance here are how hunter-gatherer groups managed to migrate successfully into a new, uninhabited, landscape and how they managed to cope with the rapidly changing environments of the time in these subarctic settings. These topics are much debated in the archeological literature (Anderson 1995; Anderson and Gillam 2000; Burmeister 2000; Golledge 2003; Hakenback 2008; Kelly and Todd 1988; Kelly 2003; Lightfoot et al. 2013; Rockman 2003; Steele, Adams and Sluckin 1998). The means by which anatomically modern humans peopled new landscapes even has been seen as one of the central questions of human history that archaeologists can address (Kintigh et al. 2014). However, such questions can only be thoroughly investigated if one has a good handle on the age and external cultural relationships and origin points of these early peoples and detailed knowledge regarding paleoenvironments. Despite the antiquity of studies of Paleoindigenous peoples in northwestern Ontario, several issues such as small point sample sizes from single sites, lack of accurate absolute dates, and a broad range of stylistic variability within projectile point assemblages that defies easy classification, have made it difficult to address assemblage relationships between sites in northwestern
Ontario and with finds elsewhere. This ambiguity has resulted in an incomplete archaeological history pertaining to the first groups utilizing the northwestern Ontario landscape.

Figure 1-1. Location of Paleoindigenous sites within the Lake Superior Basin.

Due to the antiquity of Paleoindigenous sites, material culture is often represented solely by stone tools and debris from their manufacture, the only remains that normally survive from such contexts, especially in the acidic soils of the Boreal Forest in northwestern Ontario. Archaeologists place value on projectile points, especially when they are recovered in a Paleoindigenous context. They are considered to contain a significant amount of cultural information in their shape, and in the method of manufacture, largely because they are the most “complex” of stone tools recovered. They are complex in that they involve many operations and decisions/choices in their manufacture versus other tool forms. The presumption is this complexity results in projectile points being more culturally laden with significant information. This in turn is useful in examining assemblages, and by extension population and relationships (e.g., Wilmsen 1974). The
overall morphology of projectile points often change more rapidly and hence, can be used to organize the archaeological record better in time. According to Wilmsen (1974:108) archaeologists often assume that the process of making stone tools is the result of primarily teaching or passing of information within groups and that variation between point assemblages is the result of increased degrees of social separation between those social groups in time and space (O’Brien et al. 2015; Sassman 2015; Wilmsen 1974:108). Indeed, the assumption that point forms are a measure of population relationships and different cultural ancestries and even of linguistic identity is becoming increasingly stressed in interpretations (Fiedel 1991; Sassman 2015), a return to a perspective that many had abandoned years earlier in favour of seeing those forms as being largely determined by “functional” considerations and environmental adaptations.

In northwestern Ontario point research to date has tended to follow a typological approach whereby finds are compared, and sometimes assigned to, a whole series of comparatively well-dated, named, point types/styles defined from locations in surrounding regions. These types will be described in more detail in Chapter 2. Central to these earlier studies is the idea that the more similar two (or more) assemblages of artifacts are, the more historically related and closer in time they are assumed to be (Eerkens and Lipo 2007). However, most comparisons have been impressionistic and few systematic attempts to obtain more precise and quantitative data from projectile points to explore such issues have been made. Most investigators do provide standard metric measurements of length, width, and thickness, supplemented by size ratios, discrete attribute analyses and technological/manufacturing analyses. These measurements can be used for comparative purposes, and they are more often the basis of pan-regional formal tool typologies elsewhere across the continent (see Cambron and Hulse 1969; Cheshier and Kelly 2006; Converse 1973; Deller and Ellis 1984; Ellis 1981; Flenniken and Raymond 1986; Fitting 1963; Fogleman 1988; Goodyear 1974; Henton and Durand 1991; Julig 1994; Justice 2009; Kornfeld et al 2010; Krieger 1944,1947; Lewis and Kneberg 1946; MacDonald 1968; Richie 1971; Wendt 2003). The use of linear measurements and discrete attributes, although useful, has not been successful in explaining much variability particularly within the northwestern Ontario projectile point assemblages, and especially given the small samples previously available and a
dominance of more impressionistic rather than systematic, less rigorous approaches to typological comparison.

The Mackenzie I site near Thunder Bay, Ontario, is central to this thesis and helps us to begin addressing some of the problems of previous approaches. The site is associated with an Early Holocene proglacial Lake Minong beach in the western Lake Superior basin. Although the presence of Late Paleoindigenous cultural material has been documented for more than half a century in northwestern Ontario, as stressed above, little, or no substantial point assemblages had been recovered and most have been isolated finds lacking much contextual information. Excavations at the Mackenzie I site between 2010 and 2011 produced over 3,700 diagnostic projectile points (including tips, mid-sections, bases, as well as complete specimens) (Norris 2012; Markham 2012, 2013). This total far exceeds that recovered from all previously reported sites and findspots combined.

With the larger data set from Mackenzie I, one can begin to employ a more quantitative approach to examining point morphological variability, thus creating a starting point or foundation for a more systematic approach to the issue. While a traditional point typological and attribute-based approach is not neglected, as noted above, a major focus of this research is on comparing point shape using a 3D geometric morphometric approach (3D GM). This approach has become increasingly used, in examining and comparing artifact assemblages in archaeology (see Bretzke and Conard 2012; Charlin and Gonzalez-Jose 2012; Crompton 2008; Gingerich et al. 2014; Metin and Lycett 2012) and offers a quantitative analysis of form. While it has been used several times in Paleoindigenous studies (Buchanan and Collard 2010; Buchannan et al. 2011, 2014, Shott and Otarola-Castillo 2021, etc.), it is a research avenue that has never been attempted within northwestern Ontario.

Borrowing from the field of biology, the study of geometric morphometrics (GM) is a statistical analysis of form based on Cartesian landmark coordinates (Adams, Rohlf and Slice 2005:6; Mitteroecker and Gunz 2009:235; Lawing and Polly 2009:1). In essence it is the study of shapes using points known as landmarks to denote the outline or morphology of the specimen. The landmarks positions have their own locations along the
shape, as well, they also have the “same” locations in every other form of the sample and in the average of all the forms (or projectile points) (Mitteroecker and Gunz 2009:236). The landmarks can be obtained from both 2D sources, such as a digitizing tablet, or photographs and landmark software, or in 3D form which is data that is obtained from computed tomographic (CT) point cloud scans, magnetic resonance imaging (MRI), and surface scanners that can produce high-resolution 3D representations of an objects surface using a laser (Adams, Rohlf and Slice 2005:6; Mitteroecker and Gunz 2009:235; Lawing and Polly 2009:1).

In GM, shape variables all possess the same units so that analyses are based on a covariance matrix with an established well-defined metric. Multivariate statistical methods that preserve this metric include principal component analysis (PCA), multivariate regression, and partial least squares (PLS) (Mitteroecker and Gunz 2009:242). These statistical methods, with a large enough variable sample data set will allow for a specific exploratory style of analysis, essentially a comparison of shape to determine similar form with a degree of statistical confidence that can be used to provide insights into temporal-spatial relationships of assemblages.

Previous studies of Paleoindigenous points using 3D GM approaches have focussed on inter-site comparisons often over broad areas or at a macro-level. Such comparisons are obviously a component of the present study. The inter-site analyses will compare the Mackenzie I point assemblage data with examples recovered from other surrounding areas, specifically from Manitoba and the intervening area of northwesternmost Ontario including interior sites away from the Minong Beach/strandlines, further to the north along inland lakes and streams. Additionally, points from adjacent areas in Duluth, Minnesota and the northern portions of the state are included in the comparison. It must be stressed that these assemblages were largely selected because of funding constraints or due to ease of access and, as such, the comparisons are exploratory to examine the utility of the geomorphometric techniques employed. However, they do also provide a beginning in developing a much more comprehensive data base that can be built upon in future studies by incorporating assemblages from farther afield. In addition, they can provide insights into biases in previously available samples and assist in evaluating the
ideas of previous researchers as to assemblage relationships and spatial variability and its meaning.

Finally, the analyses here also focus on point spatial variability at a more micro-level, or from within the Mackenzie I site assemblage itself, as clues to the nature of the site occupation and its history. This micro-level approach using 3D GM techniques is one that has not been previously explored in any studies. Because Mackenzie I is a large assemblage with good internal spatial control it allows for a significant examination of intra-site variation using these techniques. Hence, a portion of this research is dedicated to isolating spatial clusters/activity areas using the recoveries of projectile points and other artifacts and to seeing how points vary or not between such areas and the potential meaning of that variation. Using GIS, locational information of artifact recoveries is used to plot their distribution across the site. Point Density and Kernel Density GIS tools are employed to determine the spatial concentrations. The projectile points found within these cluster areas are compared in terms of their morphological variation as a means of commenting on group use of horizontal space and perhaps refining micro-level chronologies of site occupation.

1.2 Summary

This thesis examines in detail the large point assemblage from the Mackenzie I site, an early site in northwestern Ontario. It uses primarily, but not exclusively, a 3D GM approach to documenting shape variability in the stone points at both a micro intra-site and macro inter-site level to better understand the history of the site’s occupation and its spatial organization as well as the age and external relationships of the site at a broader regional level. The use of 3D GM approach is novel for the region and at the intra-site level has not been explored anywhere. While the region of northwestern Ontario has been subjected to decades of Paleoindigenous research (Fox 1975, 1977, 1980; Julig 1984, 1988, 1991, 1994; MacNeish 1952; Ross 1977, 1995), there has been little quantitative data to measure with a greater degree of certainty (other than professional opinion) or precision, the similarities, and differences between assemblages. This lack of certainty often leads to a patchwork of guesses as to the specific age and nature of cultural groups represented in northwestern Ontario. On a larger scale, this leads to gaps of information
when discussing population relationships and migrations of groups within North America, but on a more regional scope, information on assemblage relationships cannot be fully expressed or investigated. It is expected that the results of this research will shed light on several issues regarding Paleoindigenous activity in northwestern Ontario, namely intra site use of large-scale occupation sites as well as regional movement, interaction patterns and/or migration of Late Paleoindigenous groups into northwestern Ontario.
Chapter 2

2 Background Overview

This chapter seeks to place the western Great Lakes region into the broader context of Paleoindigenous studies by reviewing aspects of research addressing or related to archaeological material dating between ca. 11,000 and 8000 ca yr. BP. not only within the region but in surrounding areas. It also provides relevant contextual information on the Mackenzie 1 site itself.

2.1 Contextual Information

A major means used to arrange assemblages in time and space has been to compare stone points from the area with types recovered and documented elsewhere. Researchers have compared northwestern Ontario finds to types defined in those other areas. Similarities have been seen in traits exhibited by several point types that appear to indicate influences from the western plains. Specific similarities are highlighted to Plains/Southwestern types or hybrid mixtures of such types referred to as Goshen, Plainview, Agate Basin, Hell Gap, Alberta, Scottsbluff/Eden (Cody Complex), Jimmy Allen, Frederick, Lusk, and Angostura (Julig 1994:216; MacNeish 1952; Markham 2013:267; Ross 1995:249; Wormington 1957:110). Others have related the northwestern Ontario finds to types/styles defined in the Midcontinent, eastern Great Lakes and Southeast as far away as Florida such as Dalton, Cumberland, Holcombe, Suwannee and Simpson (Fitting 1969; Julig 1994:216; Markham 2013:267).

The reasons for this approach are manifest. One reason is simply that prior to the Mackenzie 1 work the most extensively excavated sites have yielded mainly unifaces or unfinished preforms rather than identifiable diagnostic projectile points. Hence, the existing point sample largely often consists of isolated surface finds. Also, the points are quite variable overall. As Ross (1995:248) notes, sites appear to produce as many point styles as projectile points. However, even if points are found, the environment and general context of boreal forest sites means they often do not have good contextual data. Collapsed stratigraphy, acidic soils which degrade organics that could be used for dating
purposes are among several factors that compromise the context of archaeological finds. There is also a sampling bias by researchers and archaeologists who tend to examine areas of archaeological potential in environments where soils are thin, where the underlying bedrock and parent material contribute to the acidity of the soils. Compounding these issues is the variability of point shapes recovered in the region. Ross (1995:249) notes that stratification within Paleoindigenous sites in the area remains an enigma. Sites often suffer from poor organic preservation within podzolic soils, with a loss of stratigraphic/contextual integrity through a host of biological transformations. For example, *floral turbation*, the process of soil disturbance by living plants, particularly tree throws or tree uprooting, produces pit mound topography (Courchesne et al. 2012:174). These natural actions disturb the surrounding soil profiles as well as displace artifacts, leaving visible marks such as inverted, twisted, and interpenetrated horizons (Courchesne et al. 2012:174; Johnson 1990). These issues are particularly problematic in situations of shallow depositional conditions. The resulting effect is either no recoverable organic materials useful for absolute dating, or uncertain context and association whereby organic materials recovered may well derive from occupations/events unrelated to the early Holocene occupations. This issue is not confined to the northwestern Ontario area but is multiregional in the boreal forest context and proves to be a vexing one (see Mullholand et al. 1997). Regardless the result is that typological comparisons are often relied on to date sites via the cross-dating technique and to speculate about the origins and cultural interaction spheres of northwestern Ontario Paleoindigenous peoples.

In order then to lay the groundwork for addressing the morphological variation of projectile points and typology in the western Great Lakes region, the following discussion will summarize and define existing cultural complexes and their associated point types/styles from the surrounding regions. Attention will be placed mainly on those complexes that have been specifically identified previously within the upper Great Lakes region mentioned above. This will be useful to identify similarities/characteristics which are potentially useful as measures of the age and cultural affiliations of the northwestern Ontario assemblages. Discussion will then move to a brief history of research on these occupations in northwestern Ontario focusing on attempts to understand central focus of this thesis, namely projectile point variability. This discussion will also involve
background into the glacial history of the area which will assist in evaluating the age of the occupations and finally end with an overview of the Mackenzie I site.

2.2 Paleoindigenous Projectile Points

In this section, an attempt is made to provide a foundation for later discussions regarding the external relationships of the Mackenzie I site points as possible clues to its age and even the origin of the earliest peoples to inhabit northwestern Ontario. In sum, it provides the opportunity to place the region into a broader context of both projectile point typologies and Paleoindigenous studies in North America.

Overall, Paleoindigenous projectile points have received considerable research attention since the first points recovered that were classified as “Folsom” in the late 1920s (Cook 1927; Figgins 1927). The focus on projectile point type and stylistic differences is simply a perpetuation of culture historical paradigms that were developed in the 1920s and 1930s. At that time, the focus of archaeologists was uniformly on answering these more cultural historical questions using the stratigraphic finds of projectile points at these early sites and the cross-dating of localities using point types as fossile directeurs. The cultural information or associations that projectile points reflected was of less concern (Sellet 2011). Linear documentation such as measurements associated with length, width and thickness, some gross elements of form (e.g., straight, or concave bases; stemmed or unstemmed, parallel-sided or expanding from the base, etc.) and technological/manufacturing aspects such as flaking patterns, were used to categorize morphological variability in projectile points to elucidate cultural chronologies and assemblage relationships. To validate interpretations of temporal meaning of these projectile point typologies, archaeologists sought stratigraphic or radiocarbon confirmation of the typological homogeneity of defined cultural complexes (Sellet 2009:97). Although this reliance on using projectile point types as chronological markers to derive a specific cultural sequence has been criticized in the past (Renfrew 1970:207; Sackett 1966:359), other researchers have used the morphology and stylistic traits of projectile points to establish frameworks that have undoubtedly aided in providing a temporal/spatial context within which one can investigate cultural interpretations (Frison 1978:18; Thomas 1986:623). Also, such are essential to interpreting any finds from
uncertain contexts that make up the bulk of the available record – they provide one of the few means to evaluate their antiquity and tie individual locations together as part of the same settlement/cultural systems. Refined and accurate chronologies are a foundation without which accurate cultural interpretations are highly suspect (e.g., Bailey 1981).

Generally, Paleoindigenous projectile points are very well-made, large, lanceolate, or slightly stemmed forms with ground side edges near the base, presumably to facilitate hafting. They are often categorized into two (sometimes more) groups: Early Paleoindigenous and Late Paleoindigenous (see, for example, Mason 1962). The distinctions between the two are based on morphological/technological traits that also have established temporal separation, notably the uniform presence in the Early Paleoindigenous category of the fluted or grooved bases, absent in the later forms. Generally, the shift from the use of Early to Late Paleoindigenous points occurred sometime between 10,500 and 10,200 RCYBP (Kornfeld et al. 2010). The identified projectile point types that are present within northwestern Ontario fall into the category of the unfluted Late Paleoindigenous types. These types and the cultural information associated with them are complex and consist of geographically and sometimes temporally overlapping styles. The cultural sequences and information about these point styles were extrapolated largely from often single component, radiocarbon dated sites representing short term events such as the Plains bison kills as at the Mill Iron and Casper sites, Wyoming. But rarer, larger, multicomponent and often stratified sites such as the Hell Gap site, Wyoming, yielded various projectile point styles found in intact stratigraphic sequences, again with radiocarbon dates, that reinforced the chronological point type sequences (Frison 1982, 1995; Irwin et al. 1965; Irwin 1969; Kornfeld et al. 2010; Larson et al. 2009).

The following summaries only focus on those Paleoindigenous types that exhibit characteristics that have been used to interpret the finds in northwestern Ontario, largely those from the western Plains/foothills (e.g., Julig 1994:216; MacNeish 1952; Markham 2013:267; Ross 1995:249; Wormington 1957:110) or that will figure in later interpretations. Some also have drawn comparisons to Late Paleoindigenous point forms from sites to the south/southeast such as concave-based, serrated edged Dalton points best known from the middle to lower Mississippi River region and beyond (Fox 1975, 1980).
or Holcombe points from the eastern Great Lakes area (Fitting 1969; Julig 1994:216; Markham 2013:267). As will be discussed in later chapters, the author finds those comparisons a bit questionable, notably because they date well before estimates of the site ages in northwestern Ontario or greater than 10,000 RCYBP. So, the focus here is on types that were initially defined largely to the west/southwest onto the Plains and as far south as Texas as well as in adjacent foothill and mountain areas.

Within the archaeological literature, the most refined projectile point typologies have come from the Plains, adjacent western foothill, and mountain areas. Extensive work in these areas, both with regards to typologies and date ranges have allowed a more concrete development of a cultural historical framework (summarized in Table 2-1).

**Table 2-1. Timeline of Plains and Foothill Mountain Paleoindigenous Complexes/Point types.**

<table>
<thead>
<tr>
<th>Subdivision</th>
<th>Plains</th>
<th>Foothill/Mountain</th>
<th>Approximate Age RCYBP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Paleoindigenous</td>
<td>Clovis</td>
<td>Clovis</td>
<td>11,000</td>
</tr>
<tr>
<td></td>
<td>Folsom</td>
<td>Folsom</td>
<td>10,500</td>
</tr>
<tr>
<td>Late Paleoindigenous</td>
<td>Agate Basin</td>
<td>Unnamed</td>
<td>10,300</td>
</tr>
<tr>
<td></td>
<td>Hell Gap</td>
<td></td>
<td>10,000</td>
</tr>
<tr>
<td></td>
<td>Goshen/Plainview</td>
<td></td>
<td>?-9800</td>
</tr>
<tr>
<td></td>
<td>Alberta</td>
<td>Alder Complex</td>
<td>9500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Ruby Valley)*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cody Complex</td>
<td>Angostura*</td>
<td>9000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Eden/Scottsbluff/Firstview)</td>
<td>Lovell</td>
</tr>
<tr>
<td></td>
<td>James</td>
<td>Constricted*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Allen/Frederick/</td>
<td>Pryor Stemmed*</td>
<td>0000</td>
</tr>
<tr>
<td></td>
<td>Lusk*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1: General timeline of Western Paleoindigenous developments synthesized from from Kornfeld et al. 2010). Asterisked developments have high percentages of points with parallel-oblique surface flaking.
Traditionally, the various recognized Paleoindigenous complexes on the Plains were seen as representing a series of separate time sequences that were not temporally overlapping within their geographic region. However, subsequent work suggests that rather than these complexes representing discrete periods of time within which there is little technological/typological variation, there may be some overlap between the various developments/types within the Plains per se (Sellett 2001). Other research also demonstrates that the typologies developed on the Plains, are largely different from the types that developed within the foothill/mountain regions as depicted in Table 1.

The Plains sequence of typologies begins with concave basal edged points, much like those of early fluted point styles such as Clovis and Folsom. They fall under the general classification of Plano as described by Mason (1962) and consist of types that are lanceolate in shape with parallel to convex side edges (Haynes and Hill 2017:249). Pressure flaking along the blade of the points are transverse to collateral with short basal thinning and are most often referred to as Plainview to the south and/or Goshen to the north (Figure 2-1A). These types could possibly overlap with the Folsom, early fluted base form found on the Plains and will be discussed in greater detail in Chapter 6.

![Figure 2-1. Plains and Foothill Mountain Late Paleoindigenous Stone Points. A: Plainview Point, Plainview Site, Texas; B: Agate Basin Point, Agate Basin Site,](image-url)
Wyoming; C: Hell Gap Point, Casper Site, Wyoming; D: Alberta Point, Hudso
Meng Site, Nebraska; E: Scottsbluff Point, Horner Site, Wyoming; F: Jimmy Allen Point, James Allen Site, Wyoming with parallel-oblique flaking. Redrawn after Sellards et al. 1947 (A) and Kornfeld et al. 2010 (B-F). Extent of basal lateral side
griding shown by short, dashed lines.

After this general sequence is a series of Plains forms also dominated by parallel to
collateral surface flaking and with more marked biconvex cross-sections beginning with
the lanceolate Agate Basin (Figure 2-1B) and then contracting stemmed Hell Gap (Figure
2-1C). As a late contemporary to the earlier unfluted forms like Goshen, the Agate Basin
points are generally longer and slender and seem to have derived from an entirely
different typological tradition. These points consistently have forms with slightly convex
to straight basal apexes in plan view. Hell Gap points have a stem, with the widest part of
the fore-section being just above the gradually sloping shoulders (generally one half to
one fourth of the length of the point). Basal apexes are generally straight, with slight
variation of convex or concave. Flaking consists of random to parallel to horizontal
transverse.

The remaining later dating points from the Plains tend to have abruptly slighter indented
shoulders and hence, are mainly stemmed. These types include forms such as Alberta,
Scottsbluff, and Eden points (see Figure 2-1D and E). The latter two types have a more
diamond-shaped cross-section and are often lumped into what is referred to as the “Cody
Complex” (Wormington 1957). On occasion, these forms have also been reported at
higher elevations in certain cave sites or in the foothill and mountain areas (Hill and
Knell 2013). Finally, the last or Terminal Paleoindigenous point type on the Plains show
a return to the more concave-based, more parallel-sided, unstemmed forms and include
types such as Frederick and James Allen (Figure 2-1F). At times Lusk forms also are
included in this designation. These types and related Terminal Paleoindigenous forms
from the adjacent foothill and mountain regions with similar flaking (see below) will be
described in more detail in Chapter 7, but Lusk forms are more like Agate Basin in shape
with convex side outlines but have shallow concave basal apexes. Despite their outline
shape differences, it is important to note that all these forms (Frederick, James Allen, and
Lusk) share a distinctive parallel-oblique flaking trait. This trait is evidenced by the
removal of flakes consistently from the upper left to lower right in a parallel manner
appearing as a “ripple” effect on the blade of the projectile point (see Figure 2-1F as an example). This kind of flaking requires considerable skill to master.

Similarly, when looking in the western foothill mountain areas, associated projectile point forms that date even earlier, or around 9500 RCYBP, have a distinctive parallel-oblique flaking pattern on the blade of the points. Given the early dates for these styles and its distinctiveness, it is most likely that this parallel-oblique flaking pattern originated in this region. Despite the similar flaking pattern, however, these forms have a wide range of morphological outline shapes although they often share a similar feature in that they exhibit a general slightly concave basal edge. A more detailed discussion of these and other point styles will be completed in Chapter Seven, but it is important to note that these forms range in shape from a more generalized lanceolate type, similar to Agate Basin (such as Ruby Valley or Angostura that tend to have lower frequency of the presence of parallel-oblique flaking) to later stemmed forms such as Lovell Constricted and Pryor Stemmed (see Kornfield et al. 2014:97-102). Despite the range in outline shape, parallel-oblique forms have been found farther to the east into Minnesota with more lanceolate concave based yet wider forms referred to by more local terms such as Browns Valley (Powell 1957:299; Wormington 1957:143) and stemmed forms called locally Minoqua points (Mason 1963; Ross 1995; Salzer 1974). Parallel-oblique flaked forms have been found in southern Wisconsin and into even northern Illinois (e.g., Loebel and Hill 2012) where they are often made on Hixton Silicified sandstone from Silver Mound in central Wisconsin (Carr and Bozhardt 2010), a material that also shows up in northern Ontario assemblages, including Mackenzie I.

### 2.3 Late/Early Post Glacial History of Northwestern Ontario and Adjacent Areas

This section will review the late glacial history of the Mackenzie I site area in northwestern Ontario as well as adjacent regions where the comparative samples were obtained. These regions include western Manitoba, Minnesota and into northwestern Ontario. This overview is completed to understand both the antiquity of the occupations and why the points from different regions used in this analysis vary, as well as possible routes of entry for the earliest peoples to inhabit the area after the retreat of the glacial ice
sheet. Of note is the development of proglacial lakes that developed after the Laurentide Ice Sheet (hereafter LIS) retreated, specifically, glacial Lake Agassiz and Lake Minong, which shaped the landscape and impacted the availability of the surrounding environment that could be exploited by peoples moving across the landscape. The review of the historic data will begin in the western portion of the study area in Manitoba and glacial Lake Agassiz then move east into the Superior Basin where the Mackenzie I site is located.

Dynamic events in all regions play an important factor in the areas people could access and move across the landscape and in Manitoba there were several distinctive macro events that shaped the landscape as well as impacted surrounding regions of interest such as Minnesota and northwestern Ontario. The Paleoindigenous history of Manitoba falls within the early Holocene between 10,000 and 7000 RCYBP. This period of time is marked by a continuation of deglaciation events that began some 18,000 RCYBP. and left the whole area clear of ice by about 9000 RCYBP (Pettipas 2013:5).

One of the largest contributing factors to the shaping of Manitoba and early human history in the area was the presence of glacial Lake Agassiz and its subsequent demise. The history and development of the lake is complex but during the late Wisconsin glaciation, the Great Lakes region was marked by distinct ice lobes from the margin of the LIS. The location of such areas, particularly in northwestern Ontario and Minnesota were influenced mainly in part, by the proglacial lowlands, the topography of which was determined not only by the stratigraphy and structure of the bedrock, but differential isostatic rebound which occurs after the ice left these regions. In Manitoba, Glacial Agassiz was the most important determinant influence on landscape development. As one of the largest, inland, Late Pleistocene lakes ever formed, the impact of its relatively rapid draining is argued to have had climatic influences around the world (Lowell et al. 2009; Teller 1995; Teller et al. 2005). Occupying an incredibly large area (see Figure 2-2), the glacial lake encompassed what is now the central portion of Manitoba, eastern parts of Saskatchewan, portions of the southwestern Nunavut, North Dakota, Minnesota, and northern portions of Ontario. During its 4000-year existence, it is thought that Lake Agassiz had at least five (5) different outlets where water poured out from the lake into other water bodies around North America impacting global climate (Leverington et al.
Figure 2-2. Outwash channels of Glacial Lake Agassiz at its maximum extent - study area outlined in red (after Teller et al. 2005).

During the existence of lake Agassiz, several phases have been attributed to the development of the glacial beaches and strand lines which surrounded the lake, that were utilized by past groups. Most notable for our discussion is the Lockhart phase, Moorehead phase and Emerson phase. These phases are pertinent to this discussion as it will be illustrated that during these events, some of the landscape was available for occupation by the varying groups in the region. The subsequent “Nipigon phase” is also important, although initial occupation of Manitoba took place sometime before this phase.

During the Lockhart Phase, Lake Agassiz levels were at their highest with shorelines such as the Herman Beach or series of beaches begin developed approximately between ~12,000 and 10,800 RCYBP (McMillan and Teller 2012). Then sometime around 10,500 RCYBP the lake experienced a massive drop in water levels (see Figure 2-3 for a
synopsis of lake levels vs time). As Pettipas (2013:8) notes, it was after the formation of the Tintah strandline that Lake Agassiz experienced an outburst of draining floodwaters, most likely along the eastern shore, as lower outlets were exposed most likely by ice retreat. Fisher and Lowell (2006:2688) bracket this phase, known as the “Moorehead Phase” between 10,675 +/- 60 RCYBP and 10,340 +/- 100 RCYBP. The massive drop in lake levels would have influenced the surrounding environment, both with regards to plant and animal species that moved into the now drained basin and human groups who would have followed. Certainly, to the west of Agassiz in southwestern Manitoba and in adjacent Saskatchewan, Folsom points dating to this interval have been recovered (Boyd 2000; Meyer et al. 2011). In this low Phase prior to ca. 9500 RCYBP people could have inhabited areas of Manitoba and northwestern Ontario that were subsequently flooded again, but no archaeological evidence has been found suggesting occupation in those areas.

![Figure 2-3. Relative changes in Lake Agassiz levels over RCYBP time (after Fisher 2005; Fisher et al. 2008; Fisher and Souch 1998; Leverington and Teller (2003); Pettipas 2013; Thorleifson 1996).](image)

The brief “Emerson phase” follows the “Lockhart phase. As seen in Figure 2-3, Agassiz Lake levels rose sharply around 9500 RCYBP to create what is called the Campbell Beach. One of the most distinguishing aspects of the phase, the Campbell beach is one of
the “most extensive, best developed, and largest…in the Lake Agassiz basin” (Teller 2001:1655). This feature would have been a dominating aspect of the landscape that could have been utilized extensively by past groups moving across the landscape as well as by the food resources they hunted.

Finally, during the “Nipigon Phase” which occurs between 9300 and 8200 RCYBP there is catastrophic discharge of water from glacial Lake Agassiz east, into northwestern Ontario as well as differential isostatic rebound. This began/influenced the development of the modern Lakes Nipigon and Superior basins and saw the gradual reduction in size of Lake Agassiz at the same time as proglacial Lake Minong was in existence in northwestern Ontario centered in the Superior basin (Leverington et al 2002:245). This discharge of water is estimated to have occurred approximately 15 times (indicated by several outlets/outwash channels shown as arrows on Figure 2-2). After each discharge the isostatic rebound at the outlets led to a brief rise of the water plane before the level dropped by subsequent down cutting at those outlets. The result is a complex series of overall drops in Agassiz Lake levels punctuated by short-term rises in between. In conjunction with the drainage of water and retreat of the LIS, isostatic rebound, which is happening after the land is free of ice, is causing upward shifts in the landscape influencing topography by isolating water into lakes and changing the elevation levels of glacial beaches.

Moving east to northwestern Ontario, the area owes a large part of its character to the fluctuations of Minong Lake levels and differential isostatic rebound. A comparison between the southeastern Lake Agassiz and the southwestern Lake Superior Basin is summarized in Figure 2-4 (after Julig 1994). Evidence of moraines, drumlines and proglacial lakes that reflect the dynamic relationship between the LIS and Lake Agassiz, played a significant role in shaping the environment and creating attractive landscapes for exploitation. These geological features formed as the result of deposited sediment from the LIS and are generally found along the lateral and/or the maximum extent of the glacier.
Moraines in northwestern Ontario were originally mapped by Zolti (1963, 1965), and have been used to create a deglaciation chronology using radiocarbon dates from basal organics preserved in depressions and lake sediments (Bjork 1985; Dyke 2004; Loope 2006; Lowell et al. 2009; Teller et al. 2005). Subsequent work by Lowell et al. (2009) used 17 radiocarbon dates in conjunction with additional 26 dates from previous research to determine the location of these moraines. This work was then used to develop a more concrete chronology of deglaciation within the region of northwestern Ontario, mainly in the Superior Basin Vicinity.

The deglaciation sequence of events for northwestern Ontario begins approximately 11,400 RCYBP, which is when the LIS had retreated to the northern limit of Minnesota (Figure 2-5A). As the ice continued to retreat north, specific events continued to play an
important role. A major event was a readvance of the LIS after a period of retreat from the area resulting in a lobe of ice, the Marquette Lobe, spreading across the Superior Basin region into Minnesota and northern Wisconsin, reaching its maximum extent just before 10,000 RCYBP (Figure 2-5A) (see Lowell et al. 1999). Prior to this event, as the LIS retreated from the Superior Basin, it had allowed Lake Agassiz to drain into the Superior Basin, a significant water level drop that initiated the Moorehead low phase in the Agassiz Basin described above. As Lydete et al. (2018) suggest, this eastern run off through the great lakes into the North Atlantic was the cause of the Younger Dryas. Subsequent routing of the runoff to the north halfway through the cooling event may have extended the Younger Drays another few centuries (Lydete et al. 2018). As the Marquette Lobe advanced, due to cooling from the Younger Dryas (Lowell et al. 1999) it blocked the eastern outlets and resulted in a water level rise associated with the transgressive Emerson Phase in the Agassiz Basin (Clayton 1983; Clayton and Moran 1982; Drexler et al 1983; Loope 2006; Teller 1985; Teller and Thorleifson 1983).

After the Marquette lobe retreats, the development of proglacial Lake Minong begins, a lake that had a dynamic effect on the landscape and went through several stages with various water levels. In total, eight separate Lake Minong related levels have been identified from evidence of strandline sequences, correlated by extrapolating known isobases to other parts of the basin (Breckenridge et al. 2010; Lewis et al. 2005; Shultis 2013). The eight identified levels are: Minong I-III, Post-Minong I-IV (Post-Minong IV also known as Dorion) and Houghton (Breckenridge et al. 2010; Farrand and Drexler 1985; Lewis et al. 2005; Shultis 2013). The strandlines are categorized into three major phases between ~9650 and 5200 RCYBP (Boyd et al. 2010) although subsequently some suggest an earlier beginning closer to 9900 RCYBP (Shultis 2013). Briefly, the Minong phase consists of the last period when marginal lakes occupied the Superior Basin and begins when the Marquette lobe retreated south (Boyd et al. 2010; Drexler et al. 1983; Lowell et al. 1999).
Figure 2.5. Glacial history of Agassiz, Minong and the Great Lakes (after Breckenridge et al. 2009 modified from several sources including Lewis and Anderson 1989; Lewis et al. 1994 and Dyke et al. 2003).

Initially it was believed that Minong beaches within the Thunder Bay region were developed at approximately 225 to 240 m asl, with wave cut features developed at higher elevations (Burwasser 1977; Phillips 1982; Julig et al. 1990). However, at approximately 10,000 RCYBP the Mackenzie Interlobe moraine was deposited at a low elevation, northeast of the Marks Moraine (shown in yellow on Figure 2.6; see Clayton 1983; Teller and Thorliefson 1983; Drexler et al. 1983; Julig et al. 1990). This Mackenzie Interlobe Moraine runs parallel to the existing Lake Superior shoreline approximately 1.5 km from the present-day shoreline and is near the location of the Mackenzie I site as well as several other Paleoindigenous sites including nearby ones called the Woodpecker 1 and 2 sites.
Shultis (2013) speculates that after the creation of the wavecut strandline at 259 m asl, Lake Minong receded to Mackenzie I site levels depositing beach sediments in the northern portion of the site (249 m asl) then as lake waters receded slightly more river-mouth sediments were deposited in the southern portion of the site (246 m asl).

Occupation of the Woodpecker sites, approximately 5 km to the west of the Mackenzie I site, are on beach sediments that subsequently developed at 240 m asl or in other words, are in a location available slightly later in geologic time. Charcoal was found with the Woodpecker 2 artifacts in a deposit buried by “beach shoreface sediments” suggesting “a nearshore depositional environment…during active beach formation” when the site was occupied (Shultis 2013: 232, 245). That charcoal yielded a date of 8680 +/- 50 RCYBP (Beta 323410) suggesting that Minong water levels continued to drop (Norris 2012). This is the latest date found in acceptable context for Late Paleoindigenous activity. Shultis (2013) suggests the overall lifespan of the various levels of Minong itself existed ca. 9900 and 9000 RCYBP, and if so the Woodpecker 2 site post-dates Minong levels per se given her interpretation of the site’s geological deposits noted above.
Regardless of the inception date and subsequent age of the various Minong levels, waters in the Superior Basin dropped considerably exposing a broad coastal plain around 8300 RCYBP (9300 cal yr BP. Yu et al. 2010). These rises and drops in lake levels combined with the retreating LIS caused numerous fluctuations or differential isostatic rebound. The absence of the weight from the LIS caused a shifting upwards of the landscape, which elevated site areas. This caused a tilt to the landscape so much so that it caused a separation between Lake Superior from Lakes Michigan and Lake Huron. The isostatic recovery of the St. Mary’s River outlet on the east side of the Superior basin at Sault Ste. Marie, which caused water levels to rise again above modern Lake Superior elevations in what is called the Nipissing Phase which reached its maximum extent ca. 6000 to 4500 RCYBP Thompson et al. 2014) (Figure 2-4). Around Thunder Bay, this feature has been documented by a well-developed wave cut feature at 210 m asl that is dated to 4500 to 5500 RCYBP (Eschman and Karrow 1985; Farrand and Drexler 1985; Hamsel et al. 1985; Julig et al. 1990; Phillips 1982).

Northernmost Minnesota where some comparative samples used in this thesis were obtained, was also affected by the geological events described above (see Hill 1995; Huber 1992, 1995, 1996; Phillips et al. 1994). However, much of Minnesota was deglaciated and remained ice free, beginning as early as 15,000 to 14,700 RCYBP (Buhta et al. 2011:13). The mid and southern portions free of ice were occupied quite early. Early Paleoindigenous points are documented from the state include the Clovis and Folsom fluted varieties as well as unfluted varieties representing several distinctive technologies described earlier, such as Agate Basin, Browns Valley, and the Cody Complex forms (Buhta et al. 2011; Dobbs and Anfinson 1993; Florin 1996; Harrison et al. 1995; Higginbottom 1996; Magner 1994; Mulholland et al. 1997, 2008; Shane n.d., 1989).

2.4 Previous Archaeological Research

This section reviews briefly the history of research of Paleoindigenous studies in the northwestern Ontario area. Rather than being comprehensive, the major focus is on how points per se have been treated in the literature so that the significance of the present research can be elucidated.
As noted earlier, investigations into the presence of Paleoindigenous groups in northwestern Ontario began in the 1950s with the excavations at the Brohm site (DdJe-1) east of Thunder Bay (MacNeish 1952). These documented for the first time the actual use of the area by the earliest groups utilizing the landscape. MacNeish (1952) developed the first hypotheses as to age and external relationships of the northwestern Ontario occupations using the seven points recovered from Brohm. At the time, however there was comparatively little-known regarding Paleoindigenous movement across the country, and indeed, all North America. Thus, this early attempt to see external connections was general, largely impressionistic, and speculative at best. MacNeish (1952) saw similarities to the overall concave-based shape and surface flaking details of the Brohm projectile points to those found much to the south at a site reported from Plainview, Texas (see Sellards et al. 1947). In sum, MacNeish (1952) offered a very coarse interpretation based on the very limited amount of information available at the time about Late Paleoindigenous assemblages located elsewhere. Nonetheless, this coarse interpretation would later influence subsequent research that documented the presence of Paleoindigenous people in northwestern Ontario.

Subsequent researchers have continued to compare northwestern Ontario finds to other types defined elsewhere largely because of the inadequacy/small size of available site samples. Similarities have been seen on traits, such as lanceolate form and concave bases, exhibited by several point types that appear to indicate largely western plains influences because estimates of the age of the sites on geological grounds largely indicate a post-10,000 to 9500 RCYBP date. While dates on known Paleoindigenous western sites (e.g., with lanceolate “Plano” point styles) date as late as 8000 RCYBP, in most areas from the Mississippi area east, with few exceptions in the westernmost Great Lakes area, those forms were replaced by notched and often serrated-edged “Early Archaic” (e.g., post-Paleoindigenous in those areas) points by 10,000 to 9500 RCYBP (see, for example, White 2021). As noted earlier, specific point similarities have been highlighted in the region to Plains/Southwestern types or hybrid mixtures of such types with lesser attention to types/styles defined more in the Midcontinent including the eastern Great Lakes area. However, Fox (1980:147-149) see traces of serrated edges on lanceolate points from the
area, which they interpret as evidence of contemporaneity and interaction with the Early Archaic makers of such points.

The reasons for this continuing approach were stated earlier but to reiterate, most point samples largely consist of surface collected, often isolated finds, and aside from Brohm, Cummins (Dawson 1963, 1983; Julig et al. 1990, Julig 1994), and Biloski (Hinshelwood 1986), most locations only yield one or two, often fragmentary or reworked points. The great variation among styles of projectile points within western Great Lakes region has also made the task of evaluating typological assessments difficult.

Given these problems, most investigators have not attempted more fine-grained point comparisons and have focused on issues such as lithic source use, association with glacial features and other geoarchaeological issues, how stone tools were made, specific interpretations of site activities and so on (e.g., Fox 1975, 1980; Hinshelwood 2004; Julig 1984, 1988, 1991, 1994). For example, Fox (1975, 1980) defined the “Lakehead Complex” in the Thunder Bay region, which included all sites with Plano points regardless of specific form/style, that were associated with the Minong beaches in the area and were focused on use of a local primary lithic source in the form Gunflint Formation silica and taconites. Ross (1995) later expanded on this work by recognizing several more local developments in a larger region of which the Lakehead Complex was only one of four. The others each having a suite of internally variable but overlapping between region point forms but focused on raw material local to their respective areas. These regional developments were subsumed into a larger development he referred to as the “Interlakes Composite.” These four regional complexes included the Lakehead Complex, Lake of the Woods/Rainy River Complex, Quetico/Superior Complex, and the Reservoir Lakes Complex.

Some more comprehensive comparative studies of points have been carried out and two are of note here as they will relate to the results of this study. Julig (1994:191-212, 215-216) compiled data on points from a range of sites including Cummins, Brohm and other Minong beach area site as well as along what he determined to be interior lakes and streams from the north and northwest. The data collected included various linear dimensions and size ratios, aspects of outline shape such as parallel versus expanding
sides, and surface flaking. A major conclusion was that there is a separation in the western Great Lake region between Paleoindigenous sites found on the glacial beach sites and those within the northern interior (Julig 1994). Sites situated on the shores of glacial beaches consisted of points with flaking patterns that have mainly transverse parallel and convergent random flaking (as seen from sites such as Brohm and Cummins), but interior sites seemed to have more collateral and parallel-oblique flaking (Julig 1994:216). Julig (1994:216) also noted that for Paleoindigenous points found in the interior, basal width was wider, predominately straight in plan outline, with shorter basal thinning scars, and including more diamond shaped transverse cross-sections when compared to glacial beach sites. This comparison led Julig (1994:216) to suggest that for sites found in the interior, projectile points were like western forms such as those of the Cody Complex and Frederick, Lusk, and Angostura types. Those found on glacial beach sites were a mixture of styles such as Holcombe points best known from the more southeastern Great Lakes area, but the sites also had marked similarities to certain types from the west (Julig 1994:216). These suggestions will be revisited in this research in a later chapter.

Markham (2013:267) recently carried out a study of projectile points recovered from the Mackenzie I site using a suite of more traditional variables and attributes to characterize the whole assemblage. She did see evidence within that single assemblage of limited morphological traits from Goshen, Plainview, Dalton, Cumberland, Suwannee, Simpson, Scottsbluff, Eden, and Jimmy Allen/Frederick/Angostura projectile point styles. However, it was argued that attempts to force the Mackenzie I points into those other typological categories was misleading. Her analysis was focused on a more “inductive” approach (Markham 2013:5) that categorized variation within the assemblage into a series of types based primarily on outline shape, which were then compared to comparably categorized assemblages from other local regional sites. Unlike Julig (1994), Markham (2013:239) found no differences between interior and Minong sites using her typological characterizations.

### 2.5 The Mackenzie Site and Its Point Assemblage

As mentioned earlier, the Mackenzie I site is situated on a glacial Minong strandline located approximately 30 km east of Thunder Bay Ontario. The site is situated on a relic
beach/strand line of glacial Lake Minong, on the west bank of what is known today as the Mackenzie River. The river itself located approximately 200 m from the east edge of the site (Figure 2-7).

![Figure 2-7. Topographic mapHighlighting the Mackenzie I site (DdJf-9) along with other associated Paleoindigenous sites on the Minong Strandline.](image)

The northern portion of the site is slightly elevated with a 3 m drop to the southern end, so the site is at an elevation between 249 and 246 m above sea level (Figure 2-8). It has been hypothesized by the author (who oversaw the excavations) that the northern portion was occupied early on, and as the waters of glacial Lake Minong receded/dropped, or isostatic rebound raised the locale to the outlet, the occupation area shifted/expanded along the southern edge of the site. As stated above, Shultis’s (2013) work on the geomorphology of the site indicates that the northern portion is consistent with a beach type environment while the southern portion is one of a river mouth type. This evidence could suggest that as the waters of glacial Lake Minong receded, the Mackenzie River developed adjacent to the southern site margin. When examining a microtopographic relief of the site area, it is apparent that just beyond the eastern side of the site, the terrain drops dramatically (Figure 2-8).
There are several other sites within proximity to Mackenzie 1 but at lower elevations (Figure 2.7). The site and adjacent locales, including the Woodpecker sites (DdJf-11, DdJf-12, DdJf-13) to the east, and the Mackenzie II DdJf-10 site to the west, were investigated over three years. Just south and at a lower elevation of the large bedrock knob at the Mackenzie 1 site (Figure 2-8) there is a small, reported site called Newton (DdJf-4; Fox 1975) that yield a single lanceolate point (categorized as Agate Basin but with parallel-oblique flaking). Markham (2013:224-225) suggests this site could be an extension of Mackenzie 1 and the author agrees with this assessment.
Excavations investigations at Mackenzie 1 itself spanned two years (2010-2011) and involved the excavation of approximately 2539 m² area in a site estimated overall to measure 100 m north to south and 95 m east to west (Figure 2-8). The excavations were centered between an area disturbed by earlier engineering soil sampling on the north margin and the bedrock knob or outcrop on the south end and southeastern side (Figure 2-8). There was no evidence of stratification in the cultural deposits.

The site is considered to be a single component with only Paleoindigenous use although it seems likely it was occupied on several occasions over time. A wide range of habitation activities were carried out. A broad range of tools were recovered from the site supporting this inference. They include knives, drills, scrapers, bifaces, projectile points, and distinctive forms found on other early sites called trihedral adzes (see Fox 1975). There is also abundant primary and secondary flaking debris. Most of the artifacts are manufactured from Taconite, a locally sourced raw material that is a part of the Gunflint Formation in northwestern Ontario. Hudson Bay Lowland Chert, Knife Lake Siltstone and Rhyolite, which are all available regionally, were also utilized. A more exotic material, Hixton Silicified Sandstone from 630 km to the south in central Wisconsin, also appears in some frequency within the Mackenzie I assemblage as debitage, flakes and formed tools. As will be described in a later chapter, all the artifacts from the site are distributed in several discrete clusters.

As noted in Chapter 1 the point sample itself from the Mackenzie I site (and adjacent Woodpecker sites) is quite large with 378 recovered. However, as the 3D GM analyses are employed on basal ends only for reasons to be discussed later, the available sample consists of 119 items including measurable basal portions alone and complete projectile points. Of the 119 specimens examined five different lateral edge types were identified: flared; straight, tapered, straight flared (one side tapered to basal edge the other flared out), and straight tapered (one side was straight and the other tapered towards the basal edge). Three basal edge shapes were recognized: concave, flat and convex. Finally, four kinds of flaking patterns were recorded: co-medial (succession of parallel flakes ending mid-portion of the point), random (no patterning to flake scars), unknown (could not be determined) and parallel-oblique. Of the 119 specimens, 36.9% of the projectile points had lateral edges that tapered towards the basal edge, while 33.6% exhibited straight
lateral edges to the basal edge (see Table 2-3). Most of the points have concave bases (75.6%) while 78.9% of the overall number exhibit parallel-oblique flaking style on at least one side of the point (see Figure 2-9 for a representative sample and Appendix A for a complete list).

Table 2-2. Total numbers of lateral edges, concave, and flaking pattern types from the Mackenzie I samples.

<table>
<thead>
<tr>
<th>Lateral Edges</th>
<th>Number</th>
<th>Basal Edges</th>
<th>Number</th>
<th>Flaking Pattern</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flared</td>
<td>16</td>
<td>Concave</td>
<td>90</td>
<td>Co-medial</td>
<td>1</td>
</tr>
<tr>
<td>Straight</td>
<td>40</td>
<td>Flat</td>
<td>27</td>
<td>Parallel-Oblique</td>
<td>94</td>
</tr>
<tr>
<td>Tapered</td>
<td>45</td>
<td>Convex</td>
<td>2</td>
<td>Random</td>
<td>18</td>
</tr>
<tr>
<td>Straight/flared</td>
<td>9</td>
<td></td>
<td></td>
<td>Unknown</td>
<td>6</td>
</tr>
<tr>
<td>Straight</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tapered</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Unknown refers to the fact the sample was too small to determine overall flaking pattern.

Figure 2-9. Representative sample of points in this research from the Mackenzie I site (these points represent a) tapered concave (WHS-3568), b) tapered flared (WHS-4846), c) straight flat (WHS-3084), d) straight concave (WHS-13810) basal types with parallel-oblique flaking and an e) straight, concave random flaking type).

A large percentage of the points made from Taconite exhibit parallel-oblique flaking arranged diagonally from upper left to lower right, while a very small number of points made from other materials (such as Hixton and Siltstone) also exhibited that flaking pattern. The percentage of items with this flaking pattern is probably much larger as it is most often visible on fore-sections rather than on snapped basal ends that make up much
of the sample used in this research. Indeed, Markham (2013:226) who examined the whole sample including snapped fore- and mid-section segments, reported that 98% of the points exhibited this pattern or traces of it. Points made from materials other than Taconite were more likely to exhibit random or unknown flaking types, suggesting that perhaps Taconite was targeted as it was more suitable for using the preferred parallel-oblique flaking method of manufacture or easier to reduce if that pattern was desired. Only if the other raw materials were of a suitable good quality to successfully the method of manufacture would parallel-oblique flaking be completed on the point. Nonetheless, it is worth stressing that parallel-oblique patterned flake removals require great skill to successfully complete and there is nothing to suggest it enhances the use capabilities of these items, suggesting it is very useful as a marker of cultural/social/historical relationships of an assemblage. In fact, parallel-oblique flaking occurs beyond points in the Mackenzie I assemblage to include clearly functionally different tools such as scrapers and bifaces suggesting it is not a “functionally” linked trait but a “cultural norm” (Markham 2013:183-184).

2.6 Summary

Investigations of the presence of Paleoindigenous groups has occurred for decades in northwestern Ontario. Until the excavations at the Mackenzie I site, very little substantial information was derived from previous investigations of particular sites and especially in terms of point forms and their variation. Isolated finds, small site assemblages and variability in projectile points shapes have made the development of a regional typology incredibly difficult.

The role in which deglaciation played in northwestern Ontario was influenced by glacial Lake Agassiz to the west. This glacial lake, which had a series of catastrophic discharges over its lifespan, play an integral role both in Manitoba as well as the development of glacial lakes in northwestern Ontario. Alternatively, Minnesota was deglaciated early on, and the events of glacial Lake Agassiz was minor to the evolution of groups migrating to the south. When the landscape in northwestern Ontario opened during the early Holocene, the environment would have been available for exploitation from either the
south or the west, areas that in the sequence of glacial retreat were both available for occupation earlier that the Superior/Minong area Ontario finds.
Chapter 3

3 Methodology

This chapter will outline the methods used to examine shape variation among the projectile point samples assembled in this research and detail the methodology used to examine spatial variability within the Mackenzie I site point assemblage.

3.1 Research Approach

The framework from which the research methods are derived is known as Geometric Morphometrics (GM). This methodology compares overall variation within a sample base to search for patterning useful in measuring the similarities and differences in shape/morphology. This research focused on the examination of basal portions of projectile points. Basal portions are arguably less affected by post-manufacture damage in use and re-sharpening and reworking, partly because they were constructed for a specific haft size and shape. In contrast, the fore-sections were much more often re-sharpened/reworked during use and this process can obscure underlying assemblage relationships when recovered in the archaeological context (Buchanan et al. 2014; Ellis 2004; Smith and Goebel 2018; Smith and DeWitt 2017; Shott et al. 2021; Thomas et al. 2017). Basal portions are also generally recovered in higher frequencies than complete points on occupation sites and thus, maximize sample size. In sum, the basal portions, as they are created for a specific haft, are less likely to be reworked, and hence, are potentially the most culturally laden portion of the tool most sensitive to changes through time and across geographic regions. It is hypothesized that the shape variation attributed to more culturally diagnostic/laden aspects on the basal portions of projectile points can be quantified using statistical means and by extension, can be used to measure the relationships of samples in time and space. The following methodology used in this research was modified from biological anthropological research (Dowhos 2018; Knigge et al., 2015; Tocheri et al. 2003, 2006; Tocheri 2007). The methodology was modified to use on basal portions of projectile points.
3.2 3D Scanning

All projectile points and point bases were scanned using the NextEngine 3D HD scanner (http://www.nextengine.com) using the NextEngine ScanStudio™ software. The resulting scan of each 3D model is a triangular mesh consisting of a discrete representation of the actual projectile point consisting of a collection of data points joined together by straight line segments, or edges, which form triangles (Figure 3-1).

The surface of the 3D image is piecewise planar – that is, each triangle is a single plane. The surface of the 3D image forms the most basic geometric projectile point model and has the same topology as the actual projectile point but is interpolated as data points. Even though an interpolating surface may pass through each acquired point, the surface is still only an approximation of the actual projectile point since any points between the sample points are not available. In essence, the ability of the model to best represent the actual projectile point depends on the number and density distribution of the sampled points. On average, the three-dimension models used in this research are high resolution triangular meshes consisting of more than 2,500 points per square inch.

Figure 3-1. Example of the triangular plane within the NextEngine 3D software consisting of a mesh of triangular points creating a 3D shape which is then used for analysis.
3.3 Geometric Morphometrics

After being scanned, the images were then imported into GM software to both quantify shape variance and compare the quantified data. Morphometrics involves the analysis of the change of shape and size between specimens and the overall nature of that change (Bookstein 1996; Lele and Richtsmeier 2001). At its root, it involves the application of a series of multivariate techniques to sets of quantitative variables such as length, width, and thickness (Adams et al. 2003:5). This analysis can involve unidimensional techniques with the use of calipers, in two-dimensional form through the use of landmarks, or in a three-dimensional environment using digital scans with landmarks, patches or meshes (Neal and Russ 2012). In physical anthropology, three dimensional morphometric techniques are well established in the comparison of past hominin species to living great apes and modern humans to determine the evolutionary relationship and functionality of specific bone structures (Baab et al. 2012; Baab and McNulty 2009; Lockwood et al. 2004). In archaeology, the use of morphometric methods has been extensively used in two-dimensional analysis of overall projectile point shape (de Azevedo et al. 2014; Brande and Saragusti 1996; Buchanan and Collard 2007, 2010; Buchanan et al. 2011, 2014; Cardillo 2010; Davis et al. 2017; Fox 2015; Gero and Mazzullo 1984; Lenardi and Merwin 2010; Okumura and Araujo 2014). Other archaeological researchers have used morphometrics on other types of artifacts recovered from sites and, more recently, three-dimensional morphometrics has begun to be employed to distinguish stylistic differences between similar types of artifacts (Bretzke and Conard 2012; Costa 2010; Gilboa et al. 2004; Gingerich et al. 2014; Grosman et al. 2008; Karasik and Smilansky 2008; Lycett 2009; Lycett and Von Cramon-Taubadel 2013; Eren and Lycett 2012; Saragusti et al. 2005).

3.4 Brief Overview of Morphometrics

Methods of morphometric analysis can be divided into two types: traditional and geometric. Traditional morphometric methodologies were developed prior to the 1980s and involved the use of linear measurements as well as counts, ratios, and angles. These measurements were used in conjunction with approaches for statistical analysis, including Principal Component Analysis (PC), factor analysis, Canonical Variates Analysis (CVA)
and discriminant function analysis (DFA) (Adams et al. 2004), to determine and compare variance in shape. These methods were concerned with the examination of the central tendencies of shape, shape variation, group differences in shape and association of shape with extrinsic factors (Adams et al. 2009; Marcus 1990; Reyment 1971; Slice 2005).

Despite the advances in statistics, mathematics and shape analysis, there were problems employing these traditional means. For example, there was no general agreement, among researchers regarding which size correction method to use when dealing with biological variation (Adams et al. 2009:6). This approach was problematic in that different size correction methods yielded slightly different results, which affected overall conclusions of the analysis. Traditional methods involving the homology of linear distances (maximum width) were not defined by homologous points (also known as landmarks). The same set of distances could be measured from two different shapes (for example tear-shape and oval) because the location of where the distances were made relative to one another was not included in the data set (Adams et al. 2009:6) (Figure 3-2). This procedure meant that distances from two different shapes (oval and teardrop) could have the same height and width values but vary in overall shape such that details of that shape were lost (Adams et al. 2009:6). Additionally, the use of methods such as principal component analysis was stunted at the time by the lack of development and application of computational technologies (Reyment 2010:10). Without the processing power of computers, analysis and conclusions were often comprised of layer upon layer of data sheets.

Figure 3-2. Comparison of landmark data from two different shapes (after Read and Lestrel (1986)).

In the example above (Figure 3-2), comparison of the sets of only just landmark data collected from the two forms makes it seem that the two forms are the same, because the location of the landmarks in each shape is at the same location. However, the outline
information of the actual shape shows differences between the two forms (after Read and Lestrel 1986).

With the proliferation of technology and the increase in computing power, researchers began to examine alternative methods for addressing shape variation. Geometric morphometrics (GM) emerged as a means of providing computationally intensive approaches for the examination and analysis of shape in multiple dimensions. A key defining characteristic is the ability to preserve the geometry of the specimen through all levels of the analysis (Adams et al. 2004). GM is essentially concerned with the geometric properties of an object that are invariant to location, scale, and orientation (Slice 2005:3). It also includes a variety of techniques that describe the geometric structures and relationships between those structures that define the measurements being taken (Fox 2013). Shape and size of specimens are mathematically separated, and each can be examined as separate variables (Fox 2013:8; Lycett and Von Cramon-Taubadel 2013).

From this revolution and the rise in the readily available computing power, two methodologies were developed within GM analysis to examine overall shape: outline methodologies and landmark methodologies (Adams et al. 2009:6). Outlining methods focus on using digitizing points along the outer edge of the shape, then fit those outlined points to a mathematical function, such as Fourier series analysis for comparison. A Fourier series is a mathematical method of marking off equally spaced points along an outline, in the process passing through a series of progressively more complex trigonometric functions for the digitized points (Reyment 2010:17). For example, SHAPE, a computer program that can delineate any type of shape with a closed two-dimensional contour, was developed in the early 2000s to evaluate variation between biological shapes in animals (Iwata and Ukai 2002). The program utilizes another program called chaincoder that scans the two-dimensional image, converts it to black and white, reduces image noise, constructs, and stores contour image information. Chaincoder is a system for describing the geometrical information about the contours in a series of numbers from 0 to 7, also known as Elliptic Fourier descriptors (EFDs). This type of analysis has been successfully applied to the study of various biological shapes in animals (Bierbaum and Ferson 1986; Diaz and Conde 1989; Ferson et al. 1985; Laurie et
al. 1997; Liu et al. 1996; Rohlf and Archie 1984) as well as plants (Furuta et al. 1995; McLellan 1993). Finally, a portion of the program then calculates and normalizes the EFDs for comparative purposes (Iwata and Ukai 2002). So, the program outlines the shape, traces the outline assigning a number from 0 to 7 at each point, then normalizes those points for comparative purposes using principal component analysis. Despite results that adequately approximate the shape of the object, there are some limitations in its use. One issue with regards to this methodology is that results cannot be linked to the homologous relationship between objects (Reyment 2010:17). Generally, only good approximates of shape can be made using this method, and some structures are not valid or stable enough to be used as a base for homologous points. In sum, the lack of a one-to-one comparison of comparable points on two objects makes it unlikely that an analysis will identify localities that are different between the forms (Lele and Richtsmeier 2001). Additionally, EFDs can only be used in cases whereby samples consist of a 2D closed shape. This characteristic means that an open-ended specimen cannot be used and limits when this methodology can be applied.

Landmarks typically have names and are based on a Cartesian coordinate system with the names representing homologous points on the specimen (Bookstein 1992:2; Mitteroecker and Gunz 2009:236). This strategy means that although each landmark has their own location, they also have the same location in every other form of the sample and in the average of all forms (Mitteroecker and Gunz 2009:236). These points of data can be checked for adequacy in covering the sample by visual or graphical display of the landmarks. Rather than reporting that the shape has changed, one can measure and report that certain structures have moved in relation to others (Rohlf and Marcus 1993:129). In some cases, homologous landmarks cannot be captured. This result prompted researchers to develop algorithms for the use of semilandmarks that treat surfaces as curves.

3.5 Semilandmarks

The use of semilandmarks or sliding landmarks in GM were developed as a means of quantifying structures on specimens with curves, contours, or topographic surfaces between two landmarks (Baab et al. 2012:152; Rohlf and Marcus 1993:129) (Figure 3.3).
Figure 3-3. Illustration of landmarks vs semilandmarks at the base of a fluted Clovis projectile point.

The geometrical relationship between the semilandmarks is not inherent in the coordinates themselves but rather is captured by fitting an appropriate function to them in either a two-dimensional or three-dimensional environment. Semilandmarks make it possible to quantify two- or three-dimensional homologous curves and surfaces and to analyze those points in conjunction with traditional landmarks (Gunz and Mitteroecker 2013:1). The number of semilandmarks depends on the complexity of the curve or surface of the specimen and the spatial scale of the shape variation of interest (Guntz and Mitteroecker 2013:2). The placement of semilandmarks is not always homologous as in the case of landmarks, but rather can differ between specimens and in number and in precise location of the n-th landmark along curves or surfaces being examined (Bookstein 1997; Skinner et al. 2009:236). Arguments in the use of biological GM have been made suggesting that researchers should use as many data points as possible so that accuracy of the shape is maintained. Meaning that redundancy in sampling for the morphology of a specimen is critical for effective visualizations and exploratory studies, as well as for estimating missing data (Guntz and Mitteroecker 2013:2-3). This is especially the case
for biological samples with smooth surfaces and relatively sublime topographic surface features. The general topography of the surface of the specimens contains such variable information both cultural and naturally derived, that to maximize the number of points of data via semilandmarks would produce information that could effectively mask the generalized shape variation that is the focus of this research. As will be discussed more below, an arbitrary threshold was determined, which produced enough data points to illustrate shape variance but minimized the redundant, minute data that was culturally and naturally derived.

For the research performed in this analysis, scans were saved as .ply files or polygon file format, a specifically designated format to store three-dimensional data from 3D scanners. The saved files from the total of 221 specimens in all the samples were then imported into Checkpoint software developed by Stratovan. The software is an integrated data package for GM that allows for the collection of both landmarks and semilandmarks data in a three-dimensional environment. The software provides a framework for the placement of a single point landmark, two points with semi-landmark curve analysis as well as a flexible “patch,” which consists of a grid of points that cover a region with edge landmarks that can be manipulated and moved for flexibility of the shape being examined. The software also allows for three-dimension visualization and rotation of the surface or specimen being examined. The method employed in this dissertation was the use of the patch, whereby 17 landmarks were chosen at the base of the projectile point on each side for a total of 34 per specimen.

Manual placement of two main homologous landmarks was situated along the basal edge, at the two corners of the projectile point. Two more landmarks were manually placed along the along the lateral edge up 4 cm from the endpoints with the fifth landmark centered in the middle of the point (Figure 3-4). Semilandmarks filled in the patch and were centred on the basal portion of the blade of the point.

In the biological sciences, landmarks fall into three categories, based on Bookstein’s (1990) classification system. These categories describe the placement of landmarks and their standardization. The first category describes homologous placement of landmarks whereby replication of the landmark position is exact. These include areas where points
in space meet along biological specimens. This is the most ideal type of landmark because the positioning of the landmark is replicated the same for every specimen. The second landmark category involves maximum curvature of biological structures and tips of predatory processes, such as on claws or teeth (Bookstein 1990:221). The final category “External Points” refers to placement of landmark positions along endpoints of a diameter of the form. Bookstein (1990:221) views this third category type rarely useful and only meaningful in a single direction representing length (“size”) of the defining segment. The categorization for the definitions of these landmarks, however, is purely set within the biological realm. Bookstein (1990) offers a very detailed definition used to describe the functional and biometrical significance, but as Sebastian et al. (2018) note, the definitions of the categories leave room for misinterpretation and misrepresentation. Given the detailed definitions of the categories and dense language Bookstein (1990) uses, most researchers rely on the first portion of the Category type and neglect detailed explanation of the role or reason for the landmarks (Sebastian 2018).

Reasons for why there was widespread use of Bookstein (1990) categorization of the types of landmarks is that they have been interpreted as qualitatively different (Sebastian et al. 2018). Category one is seen as the most homologous mainly due to the areas of placement which is easily replicable. Category two is seen as less but still important based on the geometric aspect and the third Category, while necessary is seen as the weakest. As such, Category one, as seen in the biological literature are seen as the most suitable for morphometric analysis because they are the easiest to replicate while Category three are the least (Corner et al. 1992; Guyomarc’h and Bruzek 2010; Ross and Willaims 2008; Sebastian et al 2018; Sholts et al. 2011; Simonis et al. 2009; Slice et al. 2004Sebastian et al 2018).

Given the nature of projectile points and the aim of the study, landmarks in this study fall into the third category. The overall objective is to compare the shape of the projectile points which includes the length of the specimen. Semilandmarks are used to compare the curvature of the basal edge in conjunction with the landmarks that are placed at the tops of the basal corners and 4 cm up the point. The use of 3D models, as in the types utilized in this research are becoming increasingly popular in biology and morphometrics. The software allows of almost exact replication of the placement of the landmarks and in a
sense rendering the categorization of Bookstein’s (1990) types irrelevant. For example, Sholts et al. (2011) observed the recording of 11,340 cartesian coordinates on 42 homologous landmarks using a 3D digitizer and computer models in order to compare errors in the landmark data. Their results indicate that using Bookstein’s (1990) categories, the third type is favoured when coordinate data is obtained from 3D models. They caution the recording of landmark data from various instruments as that can introduce error. In this study all landmark acquisition was completed in the same manner using the morphometric software on 3D models.

Their research demonstrates that perhaps points are more defined and are clearer when using 3D imaging software than traditional means, suggesting that certain techniques are better suited for the recording of certain landmarks (Sebastian et al. 2018:1150). As Sebastian et al. (2018:1150) suggest, “… correlations between repeatability and landmark type may exist, the nature of these correlations will differ with the modality of the data and measurement approach”. There is no uniform standard for acceptable levels of measurement error in morphometric research, and initial categorization of landmark study was limited to two-dimensional means. With the proliferation of three-dimensional software and precise scanning of three-dimensional images, replication of homologous landmark placement is easier to complete, as Sebastian et al. (2018) suggest, perhaps it is time to re-think the categorization of the types of landmarks.

The manual placement of the landmarks in this study could introduce minor inconsistencies in replication thus producing statistical irregularities. However, the 3D imaging software utilized in this study, allowed for easy manipulation and placement of landmarks, as well as scaling of the patch work of semilandmarks to ensure both coverage of the surface area, as well as replication of landmark data to minimize statistical error that could be introduced. Rotation of the image in the three-dimensional environment allowed for these landmarks to be aligned in homologous positions with the semilandmarks placed within the framework of the patch over the surface of the projectile point and along the basal edge.
Figure 3-4. Example of homologous landmark placement and semilandmark mesh created in the Checkpoint software.

The landmarks were oriented in a counter-clockwise position and, with the starting point along the proximal, medial corner (Figure 3-5). The arrows (apparent in Figure 3-4) indicate the direction on the surface of the three-dimensional model. Since it is possible to wrap a patch around the three-dimensional shape, care was taken to make sure the landmarks bordered the edge of the image in every sample. As a means of capturing the entire portion of the projectile point, the point was then flipped within the Checkpoint software and an additional patch was added. Rotation of the 3D shape in the Checkpoint software ensured that homologous landmarks lined up and with no overlapping between landmarks and semilandmarks on each patch. Each patch was placed along the basal edge, with landmarks placed on the corners, then stretched up along the lateral edges. The fifth landmark was centred between the four corners and the semilandmarks along the basal and lateral edges were adjusted so that the mesh did not slide off the edge of the point. The top of the mesh was aligned perpendicular to the basal edge 4 cm up, defining the shape of the patch (Figure 3-4 and 3-5).
Figure 3-5. Direction of the numbering of the landmarks and semilandmarks on the projectile point.

The software also allows for flexibility when determining the amount of semilandmarks to use for each patch. Users can choose dimensions between 5x5, 9x9, 13x13, 17x17, 21x21, 25x25, 29x29, 33x33, 37x37 and 41x41 to determine semi-landmark concentration. An increase from 5x5 to 9x9 increases the number of semilandmarks that are placed between the permanent landmarks on the shape. Users can then stretch the mesh patch along the surface of the 3D image into a custom shape. The increase in semilandmarks increases the amount of data captured on the surface of the object. Therefore, it is important to set a reasonable number to capture the appropriate data. Too many points could capture surficial features that were the result of tool production such as edge depressions produced by individual flake scar removals rather than overall generalized shape. Too few points would not capture the overall shape variance significantly enough to warrant comparison. It was decided that for this research a patch consisting of 17 x 17 would be sufficient to capture shape variance but avoid capturing the minute differences resulting from tool manufacture and degradation since deposition. The total number of points then on one patch was 17 multiplied by 17 totaling 867 points per side. Two patches then totaled 1734 points per specimen. Saved as .nts files, the resulting data was then imported into the R Statistical analysis program with Geomorph extension for analysis. The R Statistical program is a language environment for statistical
computing and graphics. The program is free (https://www.r-project.org) and is an integrated suite of software facilities for data manipulation, calculation, and graphical display. The Geomorph (https://cran.r-project.org/web/packages/geomorph/index.html) extension is used to read, manipulate, digitize landmark data to generate shape variables via General Procrustes Analysis (GPA) for points, curves, and surfaces, perform shape analysis and provide graphical depictions of shapes and patterns of shape variation. Once landmarks were completed, the next step was to perform a GPA on the global assemblage.

3.6 General Procrustes Analysis

One issue with the use of projectile points and broken basal portions thereof is the differences in size. Recording of landmark data captures not only information about shape, but also about location, orientation, and scale of the artifact. The differences in location and orientation of each specimen results in the differences in starting position and alignment of data when recording. In essence, the aspect of comparing different sizes is problematic and how to scale similar objects so that variation in size can be examined across the sample is an issue. The 3D software used in this analysis allows for customization of the orientation and alignment of landmark and semilandmark data. It also allows for a designation of starting point to ensure consistency of the numbering of both landmarks and semilandmarks (Figure 3-6). General Procrustes Analysis (GPA) translates these specimen configurations to a common location by superimposing their centroids (geometric centers), then scales each configuration to unit centroid size (Figure 3-6C). The analysis then standardizes the orientations by rigidly rotating all the landmark configurations until all corresponding landmarks are as close together as possible (Figure 3-6D). The resulting information then can be used to compare the variation in shape between samples (Figure 3-6E). As such, comparison of similar objects with a variation of size is not an issue since GPA removes size as a variable and compares the overall shape of the object. It is important for this analysis because it standardizes the shape of the morphology of the points and allows for a more concise comparison.

It is unclear if using an arbitrary 4 cm patch has any impact on the Procrustes analysis and thus the overall comparison of shape between all the points. The assumption for this
research is to capture only aspects from the basal end of the point, thus artificially create an assemblage whereby all basal sections were limited to 4 cm in length. The limit of the user defined patch could be indirectly influencing the results since length isn’t a reflection of size. The Procrustes analysis, however, could interpret it as such and thus, since all points are the same size, the superposition of the Procrustes analysis could be misrepresenting the overall morphology of the points since the length is a fixed measurement. The author feels, however, that despite this unknown, patching of the points the remaining analysis are sound enough to at least introduce this methodology as a means of comparing overall shape. It is like comparing an assemblage of bases that are 4 cm in size due to breakage from use. Although that scenario is highly unlikely, it is not impossible, mainly due in part to the many processes that are enacted upon artifacts, especially the hafting techniques used by Paleoindigenous groups. Regardless more study needs to be completed to ensure that a user defined limit isn’t impacting the results of the Procrustes analysis, study that goes beyond the scope of this work.

Figure 3-6. Procrustes analysis defined using fluted projectile points. (after Baab et al. 2012: Figure 1:153).
The use of GM and GPA is well established in both biology as well as physical anthropology. For example, Baab and McNulty (2009) utilized cranial measurements from Lb1 (*Homo floresiensis*) a fossil hominin and compared the results to modern humans and extant African ape species. Their results pointed to the fact that *H. floresiensis* was most like a descendent of a species of archaic Homo. Similarly, Kniggie et al. (2015) compared forelimb bones between western (low-land), mountain (highland) and Grauer gorillas (lowland and highland) populations illustrating that the differences in shape variance of the bones provided an excellent and important comparative model when studying morphological variation from early hominins.

In recent years, a relatively small number of archeologists have utilized these techniques to determine similarities and differences to overall shape of diagnostic tools, specifically projectile points. As an example, Buchanan and Collard (2010) examined projectile point blade/fore-section shape variability between the Clovis, Folsom and Plainview types using two-dimensional morphometric methodologies. At issue was the visual identification of projectile points and placing them in the traditional typology. Buchanan and Collard (2010) argued that such impressionistic means of segregating projectile point differences was insufficient. Using digital photographs of projectile points identified as Clovis, Folsom and Plainview, they determined that visually, there appeared to be differences between blade shape between the three groups. When compared as 2D morphometric data using multivariate analysis, Clovis remained distinct, while Folsom and Plainview had the same shape. In re-examining the traditional typological designations, they found that,

> there was no misclassification between Clovis and Folsom points, and only limited misclassification between Clovis and Plainview points. In contrast, many Folsom points were incorrectly classified as Plainview points and vice versa. Thus, taken together, the visual comparisons, MANOVAs, ANOVAs and DFA suggest that blade shape distinguishes the Clovis points from the Folsom and Plainview points, but not the Folsom points from the Plainview points (Buchanan and Collard 2010:357).

The type of two-dimensional analysis employed by Buchanan and Collard (2010) aides in verifying traditional typological designations of projectile points and can either strengthen traditional typologies or reinforce the need for new classifications. The
methodology, however, does have drawbacks. Traditional investigations into the variance of projectile point morphology were undertaken by the observation of linear measurements with calipers at fixed locations on the specimen. Any of the shape information is assembled indirectly using an external reference framework based on these measurements (length, width, thickness), but no geometric information is provided (Crompton 2008). Thus, the collection of data consists of an abstract collection of relative size measurements that only approximates the artifact’s morphology (Klingenberg 1996). This result is also true for those artifacts that are asymmetrical in shape. Traditional means of documentation fall short of defining the overall shape and geometry of the artifact. As MacLeod (2018:23) notes, very few researchers are capable of scanning artifacts in such minute detail to identify and record the subtle changes and differences between them, much less match the corresponding relations of morphological variation to the time, place, and environment. Noting a lack of empirical evidence to suggest that most experienced taxonomic experts possess the ability, MacLeod (2018:23) suggests that to extract patterns of morphological variation, technology should be used to enhance and augment human visual perception.

In examining the literature for two-dimensional morphometric analysis of projectile points, only complete specimens are usually used (Buchanan 2006; Buchanan and Collard 2007; Buchanan and Collard 2010; Buchanan et al. 2011). This aspect of only looking at the complete and symmetrical aspects of projectile points creates an almost false picture of the reality of past use of such tools. The analysis is dictated by the methods being employed since multivariate analysis requires complete data matrices (Buchanan et al. 2007:285). Those that are broken or asymmetrical in shape are often not considered and cannot be used for analysis. Therefore, the potentially important information stored in the remains of those tools is often simply ignored. The degree to which these broken and incomplete tools can add to the database regarding migration patterns and culturally appropriate information is unknown. Also, since few points are complete except in rare caches, samples sizes from individual assemblages are often very small and, in many cases, inadequate for a broader comparison. It is also possible that the rare complete forms found from outside of cache contexts were discarded because their shape was not considered suitable; thus, they are not typical of the desired shape. Three-
dimensional analysis focusing on basal shape can help overcome the limitations of the two-dimensional approach where only the compete points are examined. It can increase the sample size, given bases are often the found in greater numbers. By increasing sample size analysis of issues such as similarity, group identification and geographic association can be completed on a more precise level than identification with the naked eye.

Once GPA is performed, the resulting information is plotted both visually as a graph as well as numerically in the form of the numerical scores (Figure 3-7).

![Figure 3-7. Example of the distribution of projectile points based on the GPA scores PAST4.](image)

Shape difference is the square root of the sum of the squared difference in the positions of the landmarks in two shapes (Dryden and Mardia 1998). The result is a set of scores that can be compared and plotted. Generally, there are a large set of scores that represent aspects of shape variation. However, in most cases, the first two scores represent the largest shape variation within the sample. The first axis (x-axis) is the direction along which the sample shows the largest variation. The second axis (y-axis) is the direction uncorrelated to the first component along which the samples show the largest variation (Ringnér 2008:303). Given that the data has been standardized in the GPA, and each landmark and the semilandmarks have been zeroed to the average expression level, the scores are ordered according to the variance in the data they contain. This ordering means that each score then can be interpreted as the direction, uncorrelated to previous scores,
which maximizes the variance of the samples when projected along the axis (Ringnér 2008:303). If, however, variance is spread out evenly among the axes, the GPA has not been successful.

### 3.7 Warping and Statistical Analysis

The GPA offers up a glimpse of shape variance within the assemblage. To derive changes in shape variation in their essential forms, further methods can be used. To this end, warping of the overall shape variance is completed. Positive and negative vectors for selected PC scores alongside the mean specimen for the PCA were exported for warping and visualization of the shape component changes that occur. This warping was completed by exporting data into the IDAV Landmark Editor program (Wiley et al. 2005). Mean specimens for each of the selected PC score was identified in the R program and selected PC scores determined to be PC1, PC2, PC4 and PC9 where most of the shape change could be observed, were correlated to one another within the software program Landmark and merged. A new three-dimensional image of the projectile point was moved along the axis capturing obvious and subtle shape changes occurring along each axis. Midway shape was also captured (50% mean shape, 50% negative or positive vector) to understand shape change occurring between the most positive and negative values in the groups. This information is presented in Chapter 5 along with the rest of the analyses discussed above. Rather than broad generalizations highlighting overall shape changes, a more thorough interpretation of subtle morphological changes and functional implications are recognized between the groups (northwestern Ontario, Manitoba, Minnesota, and Mackenzie I). This is essential for this research given the substantial amount of variance from each group (and within group) to shape change along each axis. Such variance makes interpretation of the function and morphology difficult based solely on multivariate analysis examining positive and negative vector values and visualizations.

The calculated PC scores from the GPA were then imported into the software program PAST3. The software package was originally written for use in paleontological data analysis (Hammer 2018) but has since become a robust analysis program used in a variety of life sciences, earth sciences, engineering, and economics disciplines. Using
PAST3, a Linear Discriminate Analysis (LDA) was completed. An LDA is similar in regard to a PCA in that the analysis looks for linear combinations of variables that best explain the data and attempts to model the differences between the classes of data being examined. However, an LDA finds a hyperplane so that the projections of data in the same class have minimum variance and different classes project the maximum variance. The overall idea is to maximize inter-cluster variance and project different clusters of data as distinguishable as objectively as possible. On the other hand, PCA treats all the data the same, so the projected data have maximum variance represented. The idea is to project cluster data along a dimension such that the data points are separated. In essence, LDA is a classification methodology that is considered “supervised” whereas PCA is a data compression/dimension reduction method that is considered to be “unsupervised”. The resulting LDA data clusters then represent similarities in shape variance between groups and therefore offer up a comparison of similar and dissimilar shape variance found within the sample assemblage.

3.8 Summary

The methodology to be utilized for the purposes of this research involves use of geometric morphometrics. Shape data from four main areas, Manitoba, Minnesota, northwestern Ontario, and the Mackenzie I site will be collected into a three-dimensional environment. The total of 1734 Landmark and semi-landmark points were be placed onto the 3D shapes using Checkpoint Stratovan software. The resulting data can then be imported into the R statistical program to generate PC scores that represent shape variation. A principal component analysis and linear discriminate function analysis will be completed using the resulting PC scores in PAST3. To obtain further information regarding shape variance from a graphical standpoint, warping of shape data will be completed in Landmark Editor.
Chapter 4

4  Spatial Analysis

This chapter focuses on the spatial layout and organization of the Mackenzie I site. It outlines the methodology employed and the results of the GIS analyses. The results focus on isolating different clusters of tools/preforms anddebitage/flaking debris recovered from the site. Previous work by McCulloch (2015) completed a similar analysis, but only focused on six chosen areas from the Mackenzie I site. These areas were diverse and comparatively isolated and undisturbed from a horizontal perspective and the analytical focus was on distributions within each of those areas. In contrast, this research will focus on identifying spatial patterning and cluster areas involving not just the overall distributions of the whole assemblage but also different specific tool/preform classes (drills, knives, bifaces, scrapers, and retouched flakes) as well asdebitage, in relation to the recoveries of projectile points or whole site level distributions. Within this context, the primary focus of this research is on how this spatial patterning/artifact clustering may correspond to variation in the shape of the projectile points at an intra-site level. Considered in this way, the spatial distributions will assist in interpreting the meaning of point variation across the site in activity or stylistic/social/idosyncratic terms or at a micro, intra-site level. As an example, if clusters can be recognized with the same tool type composition/activities, but each has a restricted but different range of point shapes associated, this could indicate different individuals using each cluster. Alternatively, it could mean that each cluster represents changing spatial use over time and that the changing point shapes represent a more micro-temporal variation within the duration of site occupation. As stressed in Chapter 1, this micro-level intra-site analysis using the 3DGM approach has not been previously employed in any studies to see if it might be a useful approach to understanding site structure and organization.

The intra-site analysis is undertaken using analysis tools offered in the software package from ESRI, called ArcGIS (vers.10.7.1). This program allows for the collection, organization, managing, analyzing and distribution of geographic information. The analysis within the ArcGIS software program allows for the identification of patterns and
relationships that might otherwise remain hidden to a researcher (Burrough and McDonnel 1998:11; Kvamme 1989:143; Kvamme 1999:154; Ebert 2004:319; DeMers 2005:5; Chang 2006:1). The ArcGIS analysis methods employed for this analysis will consist of Point Density and Kernel Density analysis in conjunction with Nearest Neighbour statistics to help objectively recognize and isolate spatial patterning across the site.

4.1 Geographic Information Systems (GIS) Overview

A major objective of archaeological analysis is the context of recoveries in space and if significant patterns are evident. The analysis of archaeological recoveries is paramount to understanding human decision and influence in the past and a major component to understanding is spatial orientation (Kvamme 1989). With the advent of GIS software, specifically ArcGIS and the array of spatial statistical tools that it provides, archaeologists are equipped to document spatial patterning both on a site (intra-site) and/or regional (inter-site) levels.

Many of the objective methods of spatial analysis have been borrowed from human geography and ecological studies (Hietala 1984: iv). This borrowing was most likely in response to the fact that, although visual inspection of maps might provide valid assumptions of spatial patterning, there is difficulty in replicating the assessments made by the researchers and the inferences that those assessments support (Dacey 1973:320). Early European Paleolithic studies were perhaps the initial catalyst for interest in intra-site spatial patterning within archaeology (Hietala 1984: iv; Kroll and Price 1991:2; Johnson 1984:87; Middleton 1998:6). These studies relied on visual inspection of distribution maps from sites and the intuition of the researcher (Dacey 1973:320; Kintigh and Ammerman 1982:31; Whallon 1973:266).

The interest in intra-site spatial distribution within archaeology during the 1970s invoked a series of studies based on ethnographic data with respect to artifact patterning and spatial distribution to determine if assumptions made by archaeologists were in fact true (Chatters et al. 1995; Kroll and Issac 1984; Shott 1993). These results revealed several issues with the assumptions that archaeologists make such as: tool types should be expected to be differentially distributed across an occupation area; groups of tools should
be mutually correlated in terms of their patterns of distributions; or that tool kits should often be associated with specific cultural features or with certain types or locations of sites (Kroll and Price 1991:302; Middleton 1998:23).

This shift in the 1970s to more quantitative and objective methods for the identification of artifacts clusters and distribution patterns forced archaeologists to begin designing actualistic studies to help understand the process behind the formation of archaeological sites (Middleton 1998:23). These new studies illustrated that previous methods of spatial analysis had produced few interpretable results and little consistency (Whallon 1978; Kroll and Price 1991:302). The new information based on the studies illustrated that tool kits were not regularly discarded where they were used in single purpose activities, hearths were a focal point for numerous different refuse-producing activities, size sorting of refuse could be an important means for distinguishing where refuse-producing activities actually occurred and that numerous cultural and natural processes could rearrange refuse and artifacts distributed at sites after the initial site use (Kroll and Price 1991:197; Middleton 1998:24). These studies identified the need to fully understand site-specific formation processes, which may have influenced the distribution of artifacts (Schiffer 1972, 1983). As Spikins et al. (2002:1235-1236) note, most modern archaeological sites lack natural stratigraphy and thus archaeologists are forced to use arbitrary levels to excavate and record recoveries. The differences within an archaeological matrix are often are the result of the chemical, pedogenic and post-depositional processes in origin and are recorded as sections despite the importance of the relationship to the artifact distribution. A problem with this approach is that artifacts that may have had an association to one another or to a feature but are separated into vertical separated units and artifacts related to one another may never be associated (Spikins et al. 2002:1235).

With regards to the tools from the Mackenzie I site, spatial analysis is the primary form of examination. Spatial analysis is a means to focus on the spatial structure of variables to determine the intensity of patterns, employing the use of dot location maps created to observe patterns in the data before spatial statistics are applied (Mills 2007). In the case of archaeology, the dots represent artifact or feature distributions. Used in an archaeological setting, this idea follows on the premise that archaeological remains
reflect the spatial patterning of the activities of past people who occupied the site (Binford 1962, 1964; Schiffer 1972; Struver 1968; Wilmsen 1970). With respect to GIS spatial statistics, the role of locational data, both absolute (coordinates) and relative (spatial arrangement and distance) has major implications for which method to use (Anselin 1992). Spatial autocorrelation or spatial association follows from Tobler's (1979) First Law of Geography, in which “everything is related to everything else, but near things are more related than distant things” (Anselin 1992). This law is the premise for which spatial statistics and archaeological remains are examined.

With respect to archaeological sites and the Mackenzie I site, an estimated 9500 years have impacted the site with regards to bioturbation, cryoturbation, fluvial and alluvial processes. Despite these impacts, spatial analysis of the artifacts could hold pertinent information. This idea is based on the speculation that the Mackenzie I site is thought to represent possibly several hundred years of repeated occupation. If that is the case, then it is possible that during the repeated occupation, specialized or shifting spatial areas of activities and disposal would be apparent in the artifact distribution (Schiffer 1972:162).

These areas, as Wilmsen (1970) suggests, would be comprised of primary refuse, or refuse that has been discarded at, or at least near (see McCulloch 2015), the site of use, such as flakes resulting from tool manufacture (Schiffer 1972:161).

### 4.2 Point Density Analysis

The Point density tool calculates the density of point features around each output raster cell. From a mapping standpoint, a neighbourhood is defined around each raster cell centre, and the number of points that fall within the neighbourhood is totalled and divided by the area of that neighbourhood. In this sense, it is important to understand the input parameters as they have a significant impact to the outcome of the analysis.

Point density analysis can be used for a variety of reasons, but in this case, using it to determine densely populated areas of artifacts as a means identifying activity areas will allow for a broader examination of site use. Used in conjunction with Kernel density analysis, it will help identify locations across the Mackenzie I site with greater or fewer number of data points. This type of analysis is effective when working with data sets containing many data points in a small geographic area. Point density analysis is often
used on broader inter-site research, particularly in Europe, to test settlement patterns on larger landscapes (Casarotto et al. 2016).

4.3 Spatial Patterns

The first step in the spatial analysis was to examine the overall artifact distributions for the site. The focus was on the combined distributions of the major tool/preform categories at the site. Spatial data for the projectile points was excluded initially because a primary goal here was to see how the points specifically matched the distribution of the overall artifacts. A fishnet polygon file that comprised all the excavated units was created and used to produce a map as a polygon shapefile with a projected Coordinate system of NAD 83 Zone 16 the location of the site (Figure 4-1). This map was used as the base for all the projected artifact data from the excavations at Mackenzie I site.

![Figure 4-1. Polygon shapefile of all units excavated at the Mackenzie I site.](image)
The artifact data for the combined tool/preform categories of interest, which had been stored in an excel spreadsheet, was imported a .csv file into ArcGIS and the result was the mapping of all the tool data within the excavated units. (Figure 4-2).

Figure 4-2. Distribution of combined major tool categories (excluding projectile points) across the Mackenzie I site.
This map clearly suggests clusters are present within the data set, but the clusters and their exact margins are not always visually apparent so one must determine if there are any statistically significant areas of clustering within the overall data set of tools and preforms. Hence, all the major tools/preform categories, excluding projectile points, as shown on Figure 4-2 were combined as one layer within ArcGIS to simplify data analysis. In ArcGIS the Spatial Autocorrelation (Morans I) generates a report that identifies with statistical significance the type of data that is in the feature set. The resulting report indicates there is a positive Moran’s Index number suggesting there is clustering around statistically significant data with comparable values located near each other. The positive Z-score also indicates that the clustering is statistically significant (Figure 4-3).

![Spatial Autocorrelation Report](image)

Figure 4-3. Graphic result generated using research data, of the Spatial Autocorrelation tool suggesting significant clustering of data for the combined tools/preforms employed in the analyses.
With a positive result the analysis can proceed to further determine where exactly on the site these clusters are located.

Using the Point density selection in the Spatial Analyst toolbox, input point features were pointed to the tool category layer. The population field is the count or quaintly to be used in the calculation of a continuous surface, in the case the horizontal site boundaries of Mackenzie I. Given that each tool point represents one feature “None” was selected since each feature will be counted only once. Output cell size is the size of the output raster that will be created. This parameter has a role in the density map. Designation of larger increments results in a coarser looking map, therefore a cell size of 1 was chosen as that parameter and square metres were chosen for the output density values (Figure 4-4).

![Figure 4-4. Results of Point density analysis for the combined tools/preforms (not including points).](image-url)
The results offer insight into areas of the site whereby spatial data points of similar value occur, which are represented in the colour coding on the map. There is a larger concentration of tools in the mid-eastern portion of the map, as well as in the southern portion. These areas highlight where large number of tools were recovered.

### 4.4 Kernel Density Analysis

ArcGIS software allows for the confirmation and additional evaluation of the above cluster analysis through several other tools such as Kernel Density Analysis (KDA). This tool, much like the Point Density analysis, displays the information in a different manner by using slightly different statistical processes. Although the tools are similar, KDA spreads the known quantity of the population for each point out from the point location. The resulting surfaces surrounding each point in kernel density are based on a quadratic formula with the highest value at the center of the surface (the point location) and tapering to zero at the search radius distance. For each output cell, the total number of the accumulated intersections of the individual spread surfaces is calculated.

The goal for the use of this tool is to find the highest concentrations of tools across the Mackenzie I site, using first tools without the points, then the points themselves. Comparing the results of the Point Density and Kernel Density analysis will allow for the identification of cluster areas of artifacts thus interpreted herein as activity areas. The process is the same as the Point Density analysis, but the tool uses a different algorithm to complete the analysis (Figure 4-5). The result is reflected in the Kernel Density Analysis (KD Analysis).
Figure 4-5. Results of the KD analysis illustrating areas of clustering of combined tools across the Mackenzie I site.

When the Point Density and KD analysis are compared, the results show a strong correlation of clusters in the same vicinities (Figure 4-6), which are arbitrarily labelled for convenience.
Several spatial clusters of material are evident in the overall analyses, based on primarily the KD analyses and informed by the Point Density analyses of just the tools. Several recognizable clusters or sub-clusters appear in the mid-eastern portion of the site as well as in the north and were arbitrarily labelled for identification. Additionally, there is clustering of tools to a lesser degree in the southern edge of the site (Figures 4-6). Although there are a few spots identified in the Point Density analysis that don’t appear in the Kernel Density analysis (such as Areas G and J), the majority of the cluster areas do correlate between the two analyses. This analyses also suggests there is some degree of sub-clustering within these larger clusters, and it is very possible, given their size, that these areas were occupied several times with perhaps slight shifting of areas of use within those areas.

This clustering is further reinforced by a KD Density analysis of the both the primary and secondary flaking debris spatial patterns at the Mackenzie I site. When compared, both types of flakes illustrate that clustering is evident in the same areas (Figure 4-7) and these match the combined tools plots reinforcing the reality of such clusters.
4.5 GIS Analysis of Projectile Points

Given that clustering is evident using the combined tool data across the Mackenzie I site, and that much the same spatial clustering is seen in the flaking debris, it is important to determine if these identified areas/clusters correlate to the projectile point spatial data recovered from the site. As noted above, by highlighting this information and comparing it to the distribution of projectile points, evidence of how the site might have been organized spatially can be determined. Then, this information can be used to document how point shape may vary spatially within the site and assist in interpreting the meaning or significance of that variation.

A Point Density analysis and Kernel Density analysis were completed in the exact same manner as with the tools from the Mackenzie I site (Figure 4-8). Despite the noticeable similarities in clustering of both the combined tools and projectile points, the KD analysis for the projectile points appears spatially limited or “cut-off” noticeably at the north end, when compared with the combined tools (Figure 4-8). Also, the area available for comparison is smaller. This result is because unlike the other points recovered across the
site in the major area of clustering, none were found in the furthest northern area where area I of the combined tools lies. This lack means that the extent of analysis is smaller, and as such, the program cuts off the distribution if it goes beyond the extent of the area of available data.

Of all the point clusters identified, five locations were statistically significant in terms of the Point Density as well as having denser/stronger concentrations in terms of the KD analysis. As shown on Figure 4-9 these correspond to the labelled Areas A1, A3, B2, C and D. As these are the best-defined areas of significant clustering, the points samples from each will be used to examine intra-site shape analyses. However, there are other “outlier” areas that are discrete visually, albeit consisting of lower densities of projectile points, even if either the cluster analyses did not produce significant results, or the KD suggests a lower density of clustering.

Figure 4-8. Kernel Density analysis (left) and Point Density analysis (right) of projectile points recovered from the Mackenzie I site.
Figure 4-9. Comparison of KD analyses of combined tools (left) and projectile points (right) recovered from the Mackenzie I site.

These outliers, which correspond to Areas A2, B1, E, G and H, may represent shorter periods of use. They could provide at least clues to the sources of point variation such as, for example, short temporal periods of use with little change in styles or idiosyncratic (e.g., single user/somewhat distinct social subgroups) variation. That such areas represent “real” clusters is also strongly suggested by the fact their locations correspond closely to the combined tool/preform and flaking debris concentrations as shown on Figures 4-8.

Thus, those spatial subdivisions, labelled as Outliers 1 to 6 on Figure 4-10, will also be examined as point samples for the intra-site shape analyses.
Figure 4-10. Identification of both the Areas of concentration (yellow circles) and outlier (purple circles) clusters of projectile points.
4.6 Summary

The results of the GIS examination of horizontal spatial distribution of habitation tools and debitage from the Mackenzie I site illustrate that there are definite clusters and a high degree of statistical confidence in where that clustering occurs. Moreover, the clustering of other major tool categories and flaking debris is mirrored by where the cluster of projectile points occur. Using the spatial data, the analysis highlights at least five areas where there is a statistically significant degree of point clustering, with another six areas that although statistically significant are smaller/less dense and referred to as outliers with respect to clustering.

The mid-eastern portion of the site, or Area A appears to have had the most activity, has the most evidence of sub-clustering within it and can be inferred as a major activity centre of the site given the high frequency of tool finds. Area A, as a whole, is most likely to represent a palimpsest of different occupations over some period of time. The southern and to a much lesser extent the northern portions of the site do exhibit clusters with a degree of statistical significance and could reflect more discrete occupations by the same or different groups as used Area A or perhaps different shorter-term occupations altogether. In the following chapter these cluster site areas will be used to examine the projectile points shape variance and to determine if shape variance can be correlated to the clusters at the site. It is shown there are significant differences between some clusters and outliers and potential explanations for such patterns are reviewed.
Chapter 5

5 Shape Variation

This chapter begins first, with an examination of the results of the three-dimensional geometric morphometric (3DGM) analysis of the total scanned Mackenzie I projectile point assemblage. After a General Procrustes Analysis (GPA), shape variation, in the form of Principal Component Analysis (PCA), is plotted graphically to discover patterned variation in these data. That patterning, as well as patterning revealed in a warp analysis, is used to determine how shape variation from a 3DGM perspective is represented at the whole site level.

Second, comparisons of intra-site shape form within the site are then undertaken employing the five areas identified as clusters in the earlier GIS analysis (Areas A to E) (see Figure 4-10 in Chapter 4). Further analysis of six outlier/smaller point concentrations that lie outside these “cluster” spots is completed in a similar manner. A final intra-site PCA is completed comparing all the cluster spots and outliers in terms of shape variance. The results of the analysis will be examined to determine if the recognized site areas represent groups of similar forms of point basal shape, or if the distribution is variable (e.g., no spatial clustering of similar shape variants) with regards to basal forms. The results of a PCA, Canonical Variates Analysis (CVA), normality tests involving Marida’s and Kurtosis tests as well as a non-parametric MANOVA of both the “hot spot” cluster Areas and Outliers areas offers some degree of insight as to how shape varies spatially across the site. In turn, any spatial patterning in the point assemblage can serve as a basis for exploring the causes of that variation.

Considerable northern Ontario Paleoindigenous projectile point variability has been documented by past research and is a primary reason for the difficulties in developing and implementing a regional typology for the extreme western Great Lakes area (Fox 1975, 1980; Hinshelwood 1990, 2004; Hinshelwood and Weber 1986; Hamilton 1996, 2013; Julig 1984, 1994; Julig et al. 1989; Julig et al. 1990; Ross 1995). This analysis employs a “bottom-up” approach beginning with local variation at the site and within the site level and broadens comparisons to the immediate region to provide a foundational...
study of variation upon which broader comparative studies eventually can be carried out, and importantly, gain insights into where the Mackenzie I assemblage falls in these early occupations. However, as stressed earlier, the assemblage from the site provides the opportunity to explore the utility of this technique in recognizing and understanding finer scale variation within site assemblages, something that has not been attempted in any previous point geomorphometric studies.

The Mackenzie I site recoveries represent the largest and most comprehensive collection of Paleoindigenous projectile points from a single site in northwestern Ontario with an overall assemblage that varies considerably in both form and style. I note though, and as will become clear in a later discussion, when various geographical projectile points are compared to the Mackenzie I site sample, it is apparent that the Mackenzie I assemblage does not exhibit the full range of variation seen in other samples.

5.1 Geometric Morphometric Analysis of the Mackenzie I site Assemblage

As discussed in Chapter 3, 34 landmarks and 1700 semi-landmarks were placed on the basal portions for each projectile point using the flexible patch function in Stratovan Checkpoint software (Figure 3-4). The grid-like pattern was then placed along each homologous surface to generate large enough coverage to capture the overall complexities of shape variation, albeit not enough to capture the complexities and differences in finer scale flake scar patterning (Babb et al. 2012; Gun Gunz and Mitteroecker 2013).

Landmarks were placed along the basal corners of each point and then along the medial edges further up from the base to create a patch approximately 3 to 4 cm in size (Figure 3-4) with the final landmark centred in the middle of the sample. The landmarks were placed along the surface into a homologous position ensuring optimal coverage of the overall shape. Once exported, the coordinates were used to determine the shape variables via General Procrustes Analysis within R’s Geomorph package v 3.0.5 (Adams and Otarola-Castillo 2013).

Semilandmarks were moved along the tangential to the surface to minimize bending area before being projected back into their respective surfaces (Gunz and Mitteroecker 2013).
The GPA results are displayed in both graphical and numerical forms. The resulting shape data is captured and presented as principal component scores (PC), which are numerical representations of shape variance. As stated earlier, these quantifiable PC scores can then be examined using a Principal Component Analysis (PCA) to transform several correlated variables into a smaller number of uncorrelated variables.

The results of this analysis generated 118 PC scores that represented shape variation across the Mackenzie I assemblage. Analysis of these PC scores was undertaken to determine the nature of the shape variation associated with each score. Due to standardization, all PC scores have a mean of zero. Interpretation of PC scores is based on finding the variables that are most strongly correlated with each component (i.e., which change in shape is correlated with each component). This determination can be done graphically using the R statistical program as well as warp analysis. Initially, graphical images were used by the R statistical program because they were generated at the same time as the overall PCA. Warping was completed after this process to gain a better sense of the shape variance between each PC score. Table 5-1 represents the numerical values generated by the PCA and consist of the first 10 PC scores that relate to proportional variance.

**Table 5-1. The First 10 PC scores from the Mackenzie site assemblage.**

<table>
<thead>
<tr>
<th>PC Scores</th>
<th>PC1</th>
<th>PC2</th>
<th>PC3</th>
<th>PC4</th>
<th>PC5</th>
<th>PC6</th>
<th>PC7</th>
<th>PC8</th>
<th>PC9</th>
<th>PC10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>0.0762</td>
<td>0.0509</td>
<td>0.04011</td>
<td>0.03441</td>
<td>0.0314</td>
<td>0.02879</td>
<td>0.02572</td>
<td>0.02396</td>
<td>0.02123</td>
<td>0.02049</td>
</tr>
<tr>
<td>Deviation</td>
<td>Proportion</td>
<td>of Variance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.3193</td>
<td>0.1424</td>
<td>0.08842</td>
<td>0.06507</td>
<td>0.0541</td>
<td>0.04557</td>
<td>0.03637</td>
<td>0.03155</td>
<td>0.02478</td>
<td>0.02307</td>
<td></td>
</tr>
<tr>
<td>Cumulative</td>
<td>Proportion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.3193</td>
<td>0.4617</td>
<td>0.55015</td>
<td>0.61522</td>
<td>0.6693</td>
<td>0.71485</td>
<td>0.75123</td>
<td>0.78278</td>
<td>0.80756</td>
<td>0.83063</td>
<td></td>
</tr>
</tbody>
</table>

PC score one yields the highest proportional variance (0.31932; e.g., 32%), meaning that the majority of shape variance is captured by this single PC score out of the 118 generated. Visually it is represented on the positive axis as a shape that consists of parallel medial edges and a uniform concave basal edge that is relative thin (when compared to other PC scores) in cross-section (Figure 5-1B and D).
Figure 5-1. Representation of the positive (B, D) and negative (A, C) vectors (shape variance) for PC1.

Negative values for the PC one score are visually represented as a shape with a tapered/somewhat stemmed medial edge and a concave basal edge with slightly rounded corners cross-section that is relatively thick (Figure 5-1A and C).

Figure 5-2. Representation of the positive (B, D) and negative (A, C) vectors (shape variance) for PC2.

In contrast, PC score two represents only 14% of the overall shape variance from the assemblage (Table 5-1; Figure 5-2). This score is represented on the positive axis as also being comparatively thin, but having one straight lateral edge, one lateral side edge that is more rounded and a skewed concave basal edge (Figure 5-2 B and C) and on the negative axis as a deeply concave basal edge with rather sharper pointed corners and straight lateral edges (Figure 5-2A and D). These two extreme examples offer a visualization of the range of variability found across the whole assemblage.

Visualization of shape variance was then completed using warping analysis. This process was completed in the Landmark program for visual analysis (Figure 5-3), warping is a means by which to graphically represent the PC data for visual inspection rather than
relying on the raw numbers. The process compares the negative, mean, and positive graphical representation of shape variance of the selected individual PC scores.

![Figure 5-3. Warping analysis of the first five PC scores generated from the PCA.](image)

As seen with both the numerical representations and the warping analysis, shape variation within the Mackenzie I site assemblage for PC1 and PC2 is driven by both the form of lateral basal edges, including all forms, as well as the shape and degree of the concavity of the basal edge. These shape differences highlight what specific aspects are being compared and represented when examining the overall scatterplot of the GPA. Both the graphical representations and warping images suggest that there is substantial variability within the assemblage but that this variability is quite subtle from PC score to PC score, especially after the first 10 scores. As seen in Figure 5-3, there is considerable variability between the negative and positive axis of PC 1 and PC2. In contrast, visually the representation of variance between the positive and negative ends of the axis on PC4 and PC5 is hard to discern. The variation between the positive and negative axis of the intermediate PC3 is easy to discern visually, but when examining Table 3, PC3 only represents a very small portion of the overall assemblage (0.8%) and therefore would not
be adequate in comparing shape variance. Given that the large percentage of variance is captured by PC 1 (32%) and PC2 (14%), these scores will be used for analysis (Figure 5-4).

Figure 5-4. PCA of the Mackenzie I site projectile points with catalogue labels as revealed by plotting PC1 by PC2. Items circled in red represent extreme ends of vector plots.

The scattering of the plots in the graphs is reflective of the overall degree of variation within the assemblage but it also makes clear there is no marked evidence of sub-clustering suggesting easily recognizable different discrete “types” within the assemblage. Rather the variation seems largely continuous although there may be denser clusters of points plotted in some areas. At first glance, the results of the PCA of the Mackenzie I site assemblage alone appears to be consistent with the high degree of variation seen in Paleoindigenous projectile points found across northwestern Ontario as a whole (see below and Fox 1975, 1980: Hinshelwood 1990, 1993; Hamilton 1996, 2013; Julig 1984, 1988, 1991, 1994; Julig et al. 1990; Ross 1977, 1995). However, as hinted above, this outcome is not in fact the case.
Given the results of the PCA of the Mackenzie I site assemblage appear to represent somewhat continuous rather than highly discrete clusters of morphological similar shapes (e.g., Figure 5.4). Examination of horizontal spatial areas in relation to where they plot within the PCA could offer some idea of why such variation exists. It is important to reiterate that placement of points on the PCA will differ with regards to shape variation as represented by the x and y axis. These two components are being used as they represent the largest percentage of shape variation across the assemblage. Shape variance for these two axes is based on the overall shape of the basal edge, and whether that is a flat edge or concave, and the angle of the lateral/side edges vis a vis one another. The degree to which there is a flat edge or concave edge, the lateral edges of the basal portion, and the cross section of the point is the basis for the statistical placement of the artifact within the graph on the PCA.

The PCA is segregated into positive and negative numbers of variation creating four quadrants to the graph. For example, in the upper left section, shape variation is represented by the negative shape variance of component 1, and the positive shape variance for component 2. Points plotted within this section will have characteristics related to these two dimensions of variation. As extreme examples, on the far-left side of the graph (Figure 5-5, left) is WHS-13497 and on the extreme right side is WHS-51731 (Figure 5-5, right).

![Figure 5-5. Image of WHS-13497 and WHS-51731 the extreme left, and right specimens plotted on Figure 5-4 (scale = 1cm).](image)

This shape variation is visually represented at the extreme left of the plot as a slightly tapering point base with a flatter basal edge, a hint of a stem marked by slightly rounded shoulders and slight ear flaring at the basal corners. Parallel-oblique flaking is evident on
the basal surfaces or the section. WHS-51731, or the opposite extreme, consists of a base section with markedly tapered edges that slant/more markedly contract towards a relatively deep concave basal edge without ear-flaring (Figure 5-5, right).

The outliers then highlight the range of variation in terms of straight basal edges to concave basal edges, as well as as the basal lateral edge shape and overall thickness. As suggested above, the overall scattering of the projectile points within the PCA does suggest the assemblage represents somewhat continuous variation, making identification of discrete similar shape areas within the graph difficult. Variation could be related to short-term temporal changes within the overall period of site use, contemporaneous idiosyncratic (e.g., individual preference/social differences), or even activity differences requiring different kinds of bifaces designed for different uses or range of uses. However, there could be the small inconsistencies with the Category three type landmarks that were placed on the points. These inconsistencies could compound the variation exaggerating the separation in the plot. However, as mentioned previously, the software allowed for precise placement of the landmark data. Inconsistencies, if any, would result in such a skewed plot of variation that the graph could not be legible. The author feels that the variation plotted is an accurate representation of the shape variation being captured by the landmark data. However, as suggested previously, more study needs to be completed to determine if the user defined limits on the basal sections is inadvertently affecting the Procrustes analysis, thus exaggerating the differences.

In the absence of any vertical stratigraphy, it is difficult to evaluate whether the variation may be tied to change over time in point form. However, given the size of the site it is probable that it represents multiple usages even within a short period of overall time and is, as suggested earlier (see Chapter 4), a palimpsest of several occupations with some degree of shifting spatial use of some areas, but not necessarily all areas, over time. Additionally, there may be activity or idiosyncratic/social differences that are represented spatially across the site. Spatial patterning toolsets in GIS will be used to investigate the patterning across the site. This analysis will be completed to determine if the spatial clusters of projectile point recoveries match patterning in shape variance and if so, potential clues as to the causes of within site point variation.
5.2 Intra-Site Morphological Variation

This section explores in detail how the shape variation in the Mackenzie I points matches designated areas identified through the GIS analyses in the previous chapter (Figure 4-10). Shape variation within each area is illustrated via visual representation of the projectile points and plotting of their PC scores. The goal of this analysis is to identify any patterns of similarity or differences that might be present between the spatial areas.

As demonstrated in the previous chapter, at least five locations (Areas A1, A3, B2, C and D) were significant in terms of the Point Density analysis as well as having denser/stronger concentrations as seen in the results of the KD analysis (Chapter 4 Figure 4-10). Also 6 “outlier” areas consisting of lower densities of projectile points, for which either the Point Density did not produce significant results, or the KD suggests a lower density of clustering, were identified for further analysis. While the larger, statistically significant “Areas” might be an indication of long-term occupation use of those site areas, the outlier areas were ones that were not as statistically significant to be selected by the program. Yet, those outliers appear to be discrete visually, albeit of lower densities of items. As such, they, could represent shorter periods of use and could provide at least clues to the sources of variation such as short temporal periods of use or idiosyncratic (e.g., single user/somewhat distinct social subgroups) variation. The larger concentrations/hot spots were determined by the comparison of the Point Density analysis and the results of the kernel density analysis, which provided a strong correlation of five hot spots called “Areas” for this research.

In the following, the various areas and their constituent point assemblages are summarized and described. In a subsequent section, areas described in this section are compared to one another using GPA and CVA to see how shape variation does or does not correlate and what this may be telling us about the use of the site.

5.2.1 Area A1

Found along the far eastern side of the Mackenzie I site (Figure 4-10), this location would have sat directly adjacent to the flowing waters of the Mackenzie River. To the direct south of this location is the large outcrop of bedrock (Figure 2-8) that may have provided
shelter from prevailing southeastern winds coming across glacial Lake Minong. Area A1 includes eight projectiles with basal portions in the most densely plotted area: WHS-7167, WHS-18459, WHS-29114, WHS-8994, WHS-51820, WHS-23864, WHS-37847, and WHS-47514, and encompasses an area of approximately 7 m by 6 m or 42 m\(^2\) (Figure 5-6).

Figure 5-6. Area A1 consisting of eight projectile points in a high value zone.
Half of these projectile points (WHS-7167, WHS-23864, WHS-37847, and WHS-47514) have a slightly straight basal edge, with some lower degree of concavity to them (Figure 5-7).

![Picture of projectile points]

Figure 5-7. Pictures of the projectile points that make up Area A1 at the Mackenzie I site (scale = 1cm).

This cluster is split between flat basal edge forms and concave ones. WHS-7167, WHS-23864, WHS-37847 and WHS-47514 all have flat basal edges with WHS-7167 and WHS-23864 having considerably more basal thinning than the other two. WHS-47514 has a skewed flat basal edge, while WHS-37847 has more rounded corners and a flat basal edge. Examination of this base did not note any indication that the base had been reworked to create the flat basal edge, suggesting that the flat form was the intended shape. WHS-51820, WHS-8994, WHS-18459 all have noticeably concave edges. WHS-18459 has a shallow concave edge with larger, rounded corners and straight lateral edges. WHS-8994 has a symmetrical concave basal edge, pointed corners and straight basal edges. WHS-51820 has asymmetrical basal edge, with the apex of the concave angle being askew, as well as distinct outward ear flaring or a “fishtail”. The skewed basal form of WHS-47514 is an anomaly. Closer inspection of the basal edge did not note any
additional working or breakage of corners to indicate that the original form was concave. The flaking patterns noted suggested that this form was the final intended shape and thus was considered complete for use and included in this analysis. Finally, WHS-29114 has a very shallow concave basal edge, with large, rounded corners, one of them being the striking platform of the flake used to create the tool. Seven of the eight tools are made from various grades of Taconite and five of the seven exhibit parallel-oblique flaking. WHS-7167 appears to be made from a coarse-grained quartzite. Despite having similar basal forms (either flat or concave) there is variation in the overall shape of the point bases found in cluster A1. When examining the PCA positions of the points, there is variability in where they plot (Figure 5-8).

![Figure 5-8. PCA plot with projectile points from Area A1 highlighted (red=concave base forms; Black=straight base forms).](image)

Both the straight and concave forms plot between 0.10 and -0.05 on Component 2, but there is a broad distribution along Component 1. This plotting suggests that there is something regarding the overall shape that is influencing the distribution beyond what is discernable by the naked eye. When considering the straight basal forms alone, while there is little variation spread across the axis of Component 2, there is subtle variation along Component 1 axis. WHS-7176, which is a generally straight base with slight curvature of the basal edge, plots more along the positive section of Component 1 and
Component 2 which is further removed from the other straight edged bases. This result is most likely due to the slight concavity of the edge near the center of the base and perhaps the slight out flaring of the medial edges. To the naked eye, this appears to be inconsequential, but the nature of the program and placement of the landmarks suggests otherwise.

5.2.2 Area A3

This area consists of six points situated in a lower cluster value spatially within the GIS analysis. Situated to the north of Area A1 (Figure 4-18), this area would have offered a similar setting in that the location is directly adjacent to the Mackenzie River. Although it is found 5 m to the north of Area A1, the large rock outcrop to the south would have not provided the same type of protection if that was a consideration during site occupancy. The five points that form this area include WHS-14719, WHS-14776, WHS-1515, WHS-9421, WHS-30666 and WHS-15477 (Figure 5-9).

Figure 5-9. Area A3 which is comprised of six projectile point bases in high value zone (circled in red).
These six points were situated within at least two meters of each other, north of Area A1. Most of this area consists of point bases with concave basal edges. Two of the points exhibit straight edges that have been basally thinned (Figure 5-10).

Figure 5-10. Physical examples of the points that comprise Area A3 from the Mackenzie I site (scale = 1 cm).

Area A3 consists of 2 seemingly straight basal edged points found within the same unit. The remaining four points, which have concave basal edges are found in the surrounding area. Three of the points with a concave basal edge, WHS-1515, WHS-9421 and WHS-30666 were recovered almost within a meter of each other, while WHS-15477 was recovered almost a meter away. With regards to morphological shape variation, WHS-1515 and WHS-30666 appear to have similar basal edges. This edge appears to be shorter on one side, with an elongated edge stretching to the other side, meaning that the concave basal edge is canted or not symmetrical but skewed to one side versus the main point longitudinal axis. Both have straight medial edges from the corners of the basal edge. WHS-1515 does appear to have a broken piece along the top edge, near the corner, but physical inspection revealed that to be the striking platform of the flake that was used to
create the point. WHS-9421 and WHS-15476 appear similar in that the concave basal edge is somewhat more symmetrical than the other specimens, however WHS-9421 has lateral edges that flare out from the corner of the basal edge. This outline contrasts with WHS-15476 which has medial edges that dip in and then flare out towards the mid-portion of the point. This difference in medial edge shape is what differentiates WHS-9421 from WHS-15476.

The differences noted above is illustrated in the PCA plots in Figure 5-11. Overall, at face value these points seem to vary more than those in Area A1.

![Figure 5-11. PCA plot with projectile points from Area A3 highlighted (red=concave base forms; Black=flat base forms).](image)

When examining the PCA plot, three of the concave points plot between -0.05 and 0.05 of Component 1, while the fourth plots near -0.15 and -0.10 of Component 1. Visually, the three points (WHS-1515, WHS-9421 and WHS-30666) appear to be quite different. However, the straight edges and angle of concavity appears to be somewhat similar and as such they plot in proximity along Component 1. WHS-15477 however, has a deep concave angle, with corners that flare out and as such plots away from the other three points. WHS-14719 and WHS-14776 appear to be straight basal edged points, but upon closer examination, WHS-14776 has significantly straighter lateral edges than WHS-14719, which has edges that appear to slightly taper closer together as they reach the
base. WHS-14719 also appears to have a bulbous corner, which is a remnant striking platform of the flake that was used to make the point. WHS-14776 does have a slightly smaller ear on one corner with the striking platform on the opposite corner.

### 5.2.3 Area B2

Area B2 is found at the southern portion of the Mackenzie I site (Figure 4-18). This area is situated at the southern edge of the site, at the lowest elevation. Using the ArcGIS tool, this area was determined to have mid-level value in terms of clustering and consists of five projectile points (Figure 5-12).

![Figure 5-12. Map of Area B2 consisting of five projectile points at the southern edge of the Mackenzie I site (circled in red).](image)

From a spatial standpoint, cluster Area B2 is smaller than Area A1, but larger than Area A3 with a slightly denser concentration of points. It is considered by the ArcGIS program to be a Low-Low cluster that is surrounded by projectile points that were not statistically
included in the area. Area C consists of projectile points WHS-51809, WHS-23814, WHS-24264, WHS-81197, WHS-51815 (Figure 5-13).

Figure 5-13. Examples of projectile points that comprise Area B2 in the southern portion of the Mackenzie I site (scale = 1cm).

All projectile points within Area B2 have some degree of basal concavity but the angle and degree of the concavity varies significantly. As well, the corners differ significantly as well as the flaking. For example, WHS-51809, WHS-51815, WHS-81197 and WHS_24264 have parallel oblique flaking that extends down to the base of the point, while WHS-81197 and WHS-23814 have a comedial type of flaking pattern. The corners from a rounded type as seen with WHS-23814, WHS-51815 and to a degree WHS-24264. The basal concave angle varies substantially with WHS-23814 and WHS-51815 having a shallow concave basal edge, and WHS-51809 and WHS-24264 having deeper concave edges. Finally, WHS-81197 has an asymmetrical and uneven basal edge, with sharper pointed corners and was broken and then appears to have been reworked along the basal edge such that the relative basal concavity depth is enhanced.

Figure 5-14 highlights the fact that these points plot somewhat centrally along the middle of Component 1, and slightly along Component 2. All the projectile points apart from
WHS-51809 plot between -0.05 and 0.00 on the Component 1 axis. The variability is the result of the symmetry and degree of basal concavity that represents Component 1 but is spread across Component 2, which is measuring the variation within the basal edge and lateral sides.

Nonetheless, visually, the overall plots are relatively restricted in where they fall within the whole range of point variation across the site (Figure 5-14).

![PCA plot with projectile points from Area B2 highlighted (red=concave base forms; Black=flat base forms).](image)

**Figure 5-14.** PCA plot with projectile points from Area B2 highlighted (red=concave base forms; Black=flat base forms).

### 5.2.4 Area C

Area C is found on the west side of the Mackenzie I site east of Outlier 4 and north of Outlier 5 (Figure 4-10). The area is small, yet the ArcGIS analysis identified a high value area that consisted of only three points, WHS-31772, WHS-31692 and WHS-904. Surrounding this area are several points within a 5 m by 8 m section of the site. Given this small area, and the surrounding points are recovered from a relatively short distance
Figure 5-15. Map of Area C found on the western side of the Mackenzie I site across from Area B and southwest of Area D.

Area C is therefore treated here is comprised of WHS-31772, WHS-31692, WHS-77968, WHS-904, WHS-28855, WHS-976, WHS-6132, WHS-30571, WHS-93086, WHS-15247 in the lesser value area plus the two items in the high value area (Figure 5-16).
This area can be divided into two overall general shape forms, straight basal edge, and concave basal edge. The two points found in the highest value spatial clustering area WHS-31692 and WHS-31722 are not similar in overall shape. WHS-31692 exhibits what appears to be a straighter basal edge with straight, more parallel oriented lateral edges from the base and traces of a slight fishtail. In contrast, WHS-31722 exhibits a more concave basal edge with medial edges that expand out from the base and there is no suggestion of a fishtail. WHS-15247 and WHS-77968 are like WHS-31692 in that they have: straighter basal edges, straight and parallel lateral edges extending up from the base and suggestions of fishtails. WHS-93086 and WHS-22855 are like WHS-31772 in that they both have concave basal edges with lateral side edges that expand markedly from basal corners that are not fishtailed. WHS-904 and WHS-30571 both have what can be called a concave basal edge that forms a point/more abrupt angle at the concavity’s apex just off center of the overall point width. It appears as if WHS-30571 has more uniform
lateral edges that flare out from the base almost in a V-form, whereas WHS-904, the symmetry of the lateral edges is offset with one edge flaring out and the other being straight up to a point then flaring out. Upon closer examination of WHS-30571, there appears to be a large basal thinning channel flake removed from the base. WHS-6132 has a concave base, but with rounded corners and side edges that flare out medially. Finally, WHS-976 has a concave base, but the corners of the base are flat, with one medial edge being straight and the other medial edge angling in towards the middle of the point then out accentuating a fishtail. It is possible given the lateral edge orientation above the base and its irregularity, that this item has been resharpened/reworked in such a manner that even the basal outline has been affected. The result of such reworking would be to magnify the differences between WHS-976 and the other examples from the area.

Overall, Area C has the highest number of points, perhaps the most variance with regards to shape and the plots are distributed more widely versus the whole sample than for most other areas but there are suggestions of perhaps two or more subgroupings based on the visual characteristics above and the plots themselves (Figure 5-17).

![Figure 5-17. PCA plot with projectile points from Area C highlighted (red=concave base forms; Black=flat base forms).](image)

There is some similarity with regards to the PCA plot. Most of the concave bases tend to be placed between 0.00 and 0.05 on the Component 1 axis. This tight grouping suggests
that the overall shape and degree of the basal concave edge is uniform, although not exact. In short, although the points that have concave basal edges are not entirely identical, there is a commonality to their overall shape. Despite having a concave basal edge, WHS-93086 has some asymmetry to its shape and therefore plots to the outer edge of the axis of Component 1. The flat basal edged points plot on a similar axis on Component 2, meaning that there is some similarity with regards to shape variation but there is more variation with regards to what is identified along Component 1.

5.2.5 Area D

Area D is situated north of Outlier 2 and Area C, south of Outlier 6 (Figure 4-10). This concentration consists of WHS-19069, WHS-20914, WHS-20915, WHS-40089, WHS-5586, WHS-5654, WHS-9835 (Figure 5-18).

Figure 5-18. Map of Area D found on the eastern side of the Mackenzie I site above Area A3.

Basal edge forms in this area are a mix of concave and flat, with one looking almost concave. Four of the projectile points appear to be concave, ranging from a slight
concave edge as in WHS-40089 to a deep, symmetrical type as in WHS-20915. WHS-200914 appears to be an irregularity with an almost convex type of basal edge that appears rounded, with medial sides that taper into the middle from the corners then become straight further up the form. The overall flaking pattern for WHS-20915 is obscure on one side, due to slight (not enough to impact the morphometric result) sediment sticking to the surface but appears to be somewhat comedial on the other (side shown in Figure 5-19) with no evidence of parallel-oblique flaking. Five of the eight points are made from Taconite (WHS-19089, WHS-20914, WHS-20915, WHS-9835 and WHS-5586), while WHS-40089 and WHS-5654 are made from what appears to be a low-grade unidentifiable stone material.

![Figure 5-19. Projectile points found in Area D of the Mackenzie I site (scale = 1 cm).](image).

WHS-19069 has two flakes removed from the basal edge on the side and a randomized flaking pattern on the side not shown in Figure 5-20. The convex nature of the basal edge for WHS-20914 contrasts with most of the assemblage, possibly due to some basal reworking. There is also no evidence of parallel-oblique flaking, and the pattern of flake scaring is random by comparison to other finds from the area. The basal edges for WHS-
9835, WHS-5654 and WHS-40089 all appear to be similar in that one corner is shorter than the other. There is very little evidence of basal flake removal on WHS-9835 and WHS-40089 and there is slight evidence of parallel-oblique flaking on the upper portion of the points. WHS-9835 does have a large end thinning flake removed (on face opposite that shown) that appears to originate closer to one side of the basal edge and not the centre. WHS-5654 has several deliberate basal thinning flake removals but with a random surface flaking pattern. Finally, WHS-5586 appears to have slightly parallel-oblique flaking near the top of the point, where it appears the material contains more silicate. This means it would have been easier to flake in a predictable pattern as opposed to the base that appears to have less silicate. Two flakes have been removed from the basal edge of this point on the side with one parallel-oblique flake removal. It appears that this addition of the parallel-oblique flaking was an afterthought when the point was complete or a flake that by chance mimicked the deliberate multiple parallel-oblique flake removals seen on many other points. When plotted on the PCA, there is slight clustering of the flat based points (Figure 5-20).

Figure 5-20. PCA plot with projectile points from Area D highlighted (red=concave base forms; Black=flatter base forms).

Clustering of the flatter/less concave basal forms occurs in the upper portion of the graph between 0.00 and 0.05, seemingly rather tightly constrained. WHS-5654 also plots in this area suggesting that it is not as concave as it presents itself to the naked eye. This plotting
could be the result of the symmetry of the basal edge being slightly off center, which is interpreted by the program and placed along the positive axis of Component 2. With regards to the concave bases that are found in this area, WHS-5654 plots in the upper right corner of the graph. This placement could be due to the straight edges of the point and the slight skewing. WHS-20915 and WHS-19069 plot to the lower negative axis of Component 2 and along the positive axis of Component 1. WHS-20915 has a much deeper and more uniform concave basal edge, thus it plots close to 0.00 of Component 2, while being placed further to the right axis of Component 1. WHS-19069 has a skewed basal edge, with the deepest curve being off-centre; it thus plots close to the 0.00 axis of Component 1, but on the negative side of Component 2.

5.3 Outlier Areas of the Mackenzie I site

As previously suggested, these outlier concentrations fall outside of the statistically significant spatial clustering of the GIS tool set, largely due to a smaller sample size. However, they are most certainly identified as low-density clusters in the GIS analysis and are visually discrete (Figure 4-10). As stressed earlier, their smaller samples could represent very short-term use and help to isolate variation due to smaller scale temporal changes or idiosyncratic factors, so it is at least worth exploring to see what kind of variation they exhibit. The KD analysis which overlays the distribution of the points, was the locational data used for the analysis. As noted earlier, the constraints of this distribution make it appear as if the GIS plot was cut short at top and bottom in the following figures, but that is not the case. The analysis was only completed to the extent from which projectile points were recovered and hence, not projected beyond that area.

5.3.1 Outlier Area 1

This area lies near the very northern edge of the site (Figure 4-10) and only consists of three projectile points, WHS-36789, WHS-29425 and WHS-907 (Figure 5-21).
Figure 5-21. Outlier area one, situated at the northern portion of the Mackenzie I site.

The three projectile points from this outlier area are all concave basal sections and visually appear quite similar. Although they vary in smaller details, they are not as deeply concave as several other points from the site. WHS-907 consists of a shallow asymmetrical concave base with medial side edges that flare out from the base. Alternatively, WHS-29425 has a slightly deeper concave edge along the base with straight sides from the corners. Finally, WHS-36789 has a similar symmetrical concave edge as WHS-29425, but the medial sides flare out/expand from the corners (Figure 5-22).

Figure 5-22. Examples of projectile points from Outlier Area 1.
When examining where these points plot on the overall PCA, all three of the projectile points plot in a relatively small area in the upper margin of the PCA graph (Figure 5-23). The overall similarities in shape places them on the positive axis of Component 1 and between 0.00 and 0.05 along the axis of Component 2. WHS-907 has flat corners which could be the result of reworking or breakage either during manufacture or deposition. The overall angle of curvature of the three points appears similar, thus they are plotted relatively close on the graph. In sum, all three not only appear visually but they also seem to exhibit a relatively high degree of PCA shape similarity versus the overall PCA shape distribution (Figure 5-23).

![Figure 5-23. PCA plot with projectile points from Outlier Area 1 highlighted (red=concave base forms; Black=flat base forms).](image)

5.3.2 Outlier Area 2

The second outlier area is situated between Area A1 and Area C (Figure 4-18). An area of low-density cluster was identified here via the KD analysis, and three points situated within 1 m from the spot (Figure 5-24). These three points are WHS-31165, WHS-978 and WHS-97260. Although these points are not situated directly within the identified
cluster area, their presence within the immediate vicinity has an impact on such clustering.

Figure 5-24. Location of Outlier area 2 with associated projectile points (circled in red).

All three points have basal concave edges with varying degrees of symmetry (Figure 5-25). WHS-31165 has lateral edges that bow out along the midsection and curve in towards the corners. The curvature of the basal edge is off center, with one corner appearing shorter than the other. There is evidence of parallel-oblique flaking on the surface of the point, although it appears crude and rough but no evidence of basal thinning. WHS-978 is more uniform with straight lateral edges that taper down to the corners. The basal edge is more symmetrical, with evidence of basal thinning in the form of flakes being struck off from the basal edge. One corner is more rounded than the other, due to the presence of a striking platform from the original flake that was used to make the point. WHS-97260 is just as uniform as WHS-978, however the basal edge is not as deep. There is evidence of parallel-oblique flaking on the midsection, and the presence of a striking platform on one of the corners.
Figure 5-25. Examples of projectile points from Outlier Area 2.

Despite being found in proximity, when plotted in the overall PCA graph, the degree to which the basal edge curves places at some distance from each other but notably they fall overall within a somewhat restricted region of the plots (Figure 5-26). As with the previous outliers the restricted plotting may reinforce that this small spatial area was used only briefly and in a short time window.

Figure 5-26. PCA plot with projectile points from Outlier Area 2 highlighted (red=concave base forms; Black=flat base forms).

WHS-978 and WHS-97260 plot almost along the same axis on Component 1 based on their overall symmetrical shape of the basal edge but plot separately along the axis of
Component 2 due to the symmetry of the basal edge. WHS-978 has a slightly more asymmetrical degree to the edge which differs from WHS-97260. WHS-31165 and WHS-978 plot close together on the graph and this could be due to the similarities in the asymmetrical basal curve.

### 5.3.3 Outlier Area 3

Outlier Area 3 lies at the very southern portion of the site adjacent to Area B2 and appears as an extension off the main Area B2 cluster (Figures 4-18). Although no points lie within the actual densest KD plot area, their presence in the immediate proximity highlight the fact that there is a statistically significant clustering. The outlier region consists of points WHS-51733, WHS-99888, WHS-38606 (Figure 5-27). These points are scattered over a larger area just above the 244.5 m asl elevation.

![Figure 5-27. Map of Outlier area 3 with associated points in the southern portion of the Mackenzie I site (circled in red).](image)
Two of the points (WHS-99888 and WHS-38606) appear to have a concave basal edge although WHS-99888 appears to have a corner that has broken off (and reworked), which could influence the shape measures (Figure 5-28). Both points have straight lateral edges that taper down into the corners WHS-38606 has a more uniform, symmetrical basal edge and a slight fishtail. Neither of the point show evidence of basal thinning via retouch flakes being removed from the basal edge. WHS-51733 appears to have a flat basal edge to it, although the edge is irregular. Despite being made from a higher quality Taconite than WHS-99888, WHS-51733 has incredibly irregular flaking on the body of the point. Despite this irregular flaking pattern, there is evidence of parallel-oblique flaking, like the other two points. However, it has evidence of a slight fishtail like WHS-38606.

![Figure 5-28. Examples of projectile points from Outlier Area 3.](image)

The distribution of the three points is plotted in Figure 5-29. The three specimens are spread out given the differences between them all and perhaps accentuated by the one broken specimen. Obviously, with one irregularly flat edged point, WHS-51733 plots lower but more central of Component 1 and Component 2 Axis, while WHS-38606 plots more to the right side of the graph. WHS-99888 plots to the upper left due to the irregular shape of the basal edge and angle of concavity. Nonetheless, despite the one being broken at one basal corner, they do plot generally together in one small area versus the overall distribution of items.
5.3.4 Outlier Area 4

Situated in the far western side of the site (Figure 4-10), Outlier Area 4 is situated in an area that is statistically lower valued cluster. For this reason, it is considered an outlier rather than an actual “Area” as in the more main sections of the site. This outlier consists of four points, WHS-51684, WHS-13986, WHS-51689 and WHS-13810 are all found within 2 meters of each other (Figure 30). Their location on the west side of the site, suggests a separate or discrete activity area of possibly less intense occupation.
Figure 5-30. Map of Outlier Area 4 with associated points in the southern portion of the Mackenzie I site (circled in red).

Three of the basal edges are concave with one being considered flat, although visually it has a very slight concavity to the edge (Figure 5-31).

Figure 5-31. Examples of points recovered from Outlier Area 4.
With respect to those more definitive concave basal edged forms, WHS-51689 and WHS-13810 have a very deep concave angle, similar enough to plot close to one another along the axis of Component 2. They differ with regards to the lateral edges, WHS-51689 has lateral edge that bow in towards the corners while WHS-13810 has straight lateral edges that end at the corners. WHS-51684 also has a concave basal edge, but not as deep as WHS-51689 and WHS-13810. The lateral edges taper down to the corners and there is evidence of basal thinning in the form of retouch flakes being removed from the edge. WHS-13986 has an irregular basal edge which could be considered slightly concave. The lateral edges are also irregular but seem to taper down slightly to the corners. All four of these points exhibit evidence of parallel-oblique flaking on the mid-portion of the points.

When plotted graphically these are situated uniformly on the periphery of the total sample in the lower left of the graph, or quite differently overall from the other Areas/Outliers described above (Figure 5-32). Once again this may suggest brief periods of use due to, among other possible explanations, being closer in time.

Figure 5-32. PCA plot with projectile points from Outlier Area 4 highlighted (red=concave base forms; Black=flat/irregular base forms).
With regards to the PCA plot, WHS-13986 plots further to the left side of the graph between 0.00 and 0.05 on Component 1 and between -0.15 and -0.20 on Component 2. This could be in-part due to the straighter lateral edges and somewhat flat basal edge. WHS-13810 and WHS-51689 plot between 0.00 and -0.05 on Component 1 and but differ slightly on placement along Component 2. WHS-13810 plots between -0.10 and -0.15 and WHS-51689 plots between 0.00 and -0.05. These two have very deep basal concave edges and straight lateral edges. While WHS-51689 is more symmetrical, with finer basal corners, WHS-13810 is slightly off centre with sharper basal corners, which explains the subtle difference in placement on the graph. Finally, WHS-51684 which has a shallower basal concave angled edge and slightly flaring lateral edges plots between 0.00 and -0.05 on Component 1 and between -0.05 and -0.10 on Component 2. It resembles a more ideal symmetrical base and therefore plots furthest to the right. Once again, parallel-oblique flaking is present but in varying degrees, which will also affect the distribution of the points.

5.3.5 Outlier Area 5

This area (Figure 4-18) consists of two points WHS-57707 and WHS-977 (Figure 5-33).

Figure 5-33. Map of Outlier Area 5 with associated points in the southern portion of the Mackenzie I site (circled in red).
In essence this area summaries the differences of shape variation found across the Mackenzie I site. WHS-57707 is an irregular flatter basal edge (possibly reworked), while WHS-977 has a concave basal edge. There is evidence of parallel-oblique flaking on the two projectile point bases, with evidence of pronounced basal thinning along the edge of WHS-977 (Figure 5-34).

Figure 5-34. Two points recovered from Outlier 5 at the Mackenzie I site.

The two points obviously differ in basal shape and is apparent in visual examination. This morphological difference is also expressed in the PCA plot as seen in Figure 5-35.

Figure 5-35. PCA plot of WHS-57707 and WHS-977.
5.3.6 Outlier Area 6

This area is situated in the mid-northern portion of the Mackenzie I site (Figure 5-36).

**Figure 5-36.** Outlier Area 6 located in the mid-northern portion of the Mackenzie I site.

The area consists of three projectile points that make up the cluster, WHS-7873, WHS-861 and WHS-8107 (Figure 5-37).

**Figure 5-37.** Examples of the projectile points recovered from Outlier Area 6 at the Mackenzie I site.
These three points all have basal edges that are concave. All three points exhibit parallel-oblique flaking, but the interesting thing is that WHS-7873 is made from Hixton silicified sandstone, a material that is only found in central Wisconsin to the southeast. The other two points (WHS-861 and WHS-8107) are made from local Taconite. Although it is not readily apparent to the reader, the grade of Taconite from which WHS-8107 is made, is a poorer type. Evidence can be seen when examining the base that it is a brittle, more degraded form of the material and can be identified by the colour change from the blacker material to the beige, almost red-looking, base. In contrast, WHS-861 is made from a higher grade of Taconite, with a higher silica content, which makes the stone easier to shape with more pronounced and definitive flake scars. WHS-7873 is smaller than the other two, and it appears that one of the corners was broken and then reshaped and rounded out more. WHS-861 and WHS-8107 both have symmetrical concave basal edges, but WHS-861 has a lateral edge that angles in towards the medial portion of the point then angles back away, with the other side being straight. WHS-8107 has lateral edges that simply angle out from the corners and a presumed use chip in the upper fore-section on one edge that was sharpened for continued use. As expected, given the difference between all three points, plotting of the PCA shows how different they are from one another (Figure 5-38).

![Figure 5-38. PCA plot with projectile points from Outlier Area 6 highlighted](image-url)
Due to the overall basal edge form and lateral sides, the PCA plot distributes the points in an expected manner. With similar basal edge concave angles, WHS-861 and WHS-8107 plot between 0.00 and 0.05 on Component 2 axis whereas WHS-7873 with its irregular basal edge plots between -0.05 and -0.10 on the Component 2 axis, quite a distance from the other two. With regards to Component 1 axis, WHS-8107 falls close to -0.05 and WHS-861 close to 0.25 and is most likely due to a combination of basal edge shape and flaking near the base. Although it is hard to discern, WHS-8107 base consists of a relatively poor grade of Taconite. This poor grade has an overall effect when knapping the base due to the material being brittle and even more unpredictable when flaking the tool. WHS-861 is a higher-grade Taconite and thus shaping both the base and the point would have been easier and more predictable.

5.4 PCA Comparison of Cluster and Outlier Areas

In this section, the question of whether the variation in point form is patterned spatially in relation to those different site spatial subdivisions will be examined. Chapter 4 illustrated that highlighting such areas has at least the potential to unravel the site occupation history by documenting contrasts that are reflected in micro-temporal and/or contemporaneous social/idiosyncratic and/or activity differences. Before this analysis there are several factors that need consideration.

First, if we ignore the small sample size, it will become clear in the following chapter that range of variation in the Mackenzie I assemblage is quite restricted versus what is seen in the total sample of Late Paleo points from the broader region collected over the past decades. This restricted variation could suggest that the site was only used for a short period of time and/or only represent a segment of the overall Paleoindigenous occupations of the time. If that is the case, then any differences in shape variation would be expected to be minor and not easily detectable by the naked eye.

Second, the information derived from the overall GM analysis suggests that instead of a definite sub-clustering of discrete morphological shape types, variability is over more of a continuous range of shape. Among other things, this might suggest that at micro-temporal scales, change could be incremental and continuous, thus reducing the chance of statistically measurable differences between areas.
Third, there is a presumption that at least some areas, notably several of the smaller or more ephemeral ones, such as the outliers, were occupied once or for much shorter periods of time, such that recovered points reflects solely that time period. This means that even briefer, earlier or later periods of occupation that resulted in even only single point being discarded could and would obscure patterning overall in such small samples. There is even a real possibility that later occupants of the site could have and would have scavenged artifacts from previous occupations for their own use (see for example, Dibble et al 2017; Haas et al. 2019). In doing so, reworking of their own accord would obscure any patterning that may have existed. Nonetheless, as suggested in the preceding discussions, some areas/outliers seem to have a restricted range of plotted variation.

Given these considerations, the attempt here to search for documented patterning was meant to be exploratory, to see if suggestions of patterning warranted further investigation. Such kinds of micro-spatial variation have not been considered in most previous analyses of larger Paleoindigenous point assemblages and even when they have (Deller and Ellis 1992; Wilmsen 1970) they have not used 3D GM methods and have been more impressionistic. Regardless, the General Procrustes analysis (GPA) on the 56 points that comprise the two data sets (Areas and Outliers) was completed and compared to the spatial locations of the various projectile points. The result of the GPA was 54 PCA scores that represented shape variation across the two groups. Of the 54 PCI points, a low PCI 1 (29%) and PCI 2 (16%) together accounted for 45% of the overall shape variance within the assemblage and were used in the analysis. Along the PC 1 component, the positive end is represented by a slightly curved lateral edged basal form with rounded corners and a mid-depth concave basal edge (Figure 5-39). The negative component is represented by a straight lateral edge with slightly squared corners and a shallow concave basal edge. Along PCI 2, the negative end is represented by an asymmetrical form, with one corner slightly round and exaggerated and the other corner pointy. The lateral edges curve towards the base and the basal edge is incredibly deep. On the positive end of the PC2, the basal form is squarer, with straight lateral edges and a very shallow concave basal edge.
To investigate the nature of shape variation between the two groups, the shape data was imported into PAST4, and a PCA completed. Results of the PCA, once again, highlight the variability within these specific data sets from the assemblage (Figure 5-40). On the extreme negative portion of Component 1 (the x-axis) and extreme positive portion of Component 2 (the y-axis) is WHS-51689. The lateral edges of the point taper to the base, which has a deep concave basal edge (Figure 5-41). At the other end of the graph, on the extreme positive end of Component 1 and the extreme positive portion of Component 2 is WHS-20914 (Figure 5-41). This artifact is represented by a point that has lateral edges that flare out towards the base. The edge is convex/flat and appears to be almost rounded although the item may have had some basal reworking, magnifying its peripheral plotted position/shape.

Between these points on the graph, the distribution of shape variation (Figure 5-40) is just as variable as it is when compared to the overall PCA of the whole Mackenzie I assemblage as described earlier. Considering that this analysis is only comprised of concave and flat basal forms associated with the PC1 and PC2 axis of the PCA, and not the other PC results, there is still a wide range of variability across the graph. Examining the distribution graph, several points plot in the upper positive portion of Axis 2 but are spread across the positive and negative portions of Axis 1 (Figure 5-40). It appears that shape variation is once again, largely driven by the shape of the basal edge concavity and not so much by the lateral edge forms.
Figure 5-40. PCA of both the GIS identified areas and outlier areas from the Mackenzie I site.
Whatever the case, even on Figure 5-40 there is a suggestion visually that the points from different areas/outliers tend to cluster and plot in different areas of the graph such as all the points at right in green, which are from the same cluster (Area D). To better understand shape variation and how that variance is represented between the spatial clusters of the Mackenzie I assemblage, a Canonical Variates Analysis (CVA) was completed to comparing the overall shapes of the points from both the Areas and Outliers.

In PAST4, this procedure assigns each point to the group that gives the minimal Mahalanobis distance to the group mean. The Mahalanobis distance is calculated from the pooled within-group covariance matrix, giving a discriminant classifier. In PAST4, the group assignment is also cross validated by a leave-one-out cross validation (jackknifing) procedure (Hammer 2018:108). When plotted using an CVA, the groupings of the identified areas become more apparent. Plotting of the different areas as convex hulls allow a more efficient visual representation of shape variance that is present across the areas of point concentrations/clustering (Figure 5-42). Visually these plots indicate
that there is suggestive spatial patterning in point morphological variation, confirming the initial impression from Figure 5-40.

As Figure 5-42 highlights, Area C, which had the highest number of projectile points, and highest range of variation, encompasses a large area on the plot. Overlapping the Area C plot are Outlier Area 2 and Area B2 to the left of the plot and Area A1, Area A3, Outlier Area 1 and Outlier Area 6, which concentrate to the right edge of the Area C plot. Finally, there are two areas that plot separately (Outlier Areas 3 and 4) from the other groups or with minimal overlap to any of the other groups: Area A, Area A3, Area B2, Area C, Area D, Outlier Areas 1, 2, 5 and 6. Perhaps of note, Area D only overlaps with Area A1 due to single outliers from both areas. These outlier points could result from overlapping slightly different temporal uses or scavenging of artifacts from earlier occupations, both of which, as noted above, can obscure patterning. One could even envision the one point from A1 that plots and overlaps with Area D was more contemporary with A1 and left earlier or later than the main use of Area D.
Figure 5-42. A between-group CVA of the GIS clusters at the Mackenzie I site.
The convex hull plots provide visually suggestive evidence there is spatial patterning in the point basal shapes from the site. To determine if this patterning is statistically valid, first, a multivariate normality test was completed in PAST4 that computes the Mardia’s multivariate skewness and kurtosis, with tests based on chi-squared (skewedness) and normal (kurtosis) distributions within groups (Figure 5-43). In PAST4 the omnibus test of Doornik and Hansen (1994) is also given.

<table>
<thead>
<tr>
<th>Mardia tests</th>
<th>Value</th>
<th>Statistic</th>
<th>df</th>
<th>( p ) (normal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skewness</td>
<td>0.7189</td>
<td>6.59</td>
<td>10</td>
<td>0.7635</td>
</tr>
<tr>
<td>Skewness, small sample corrected</td>
<td>7.141</td>
<td>10</td>
<td>0.7121</td>
<td></td>
</tr>
<tr>
<td>Kurtosis</td>
<td>13.42</td>
<td>-1.071</td>
<td>10</td>
<td>0.284</td>
</tr>
</tbody>
</table>

**Figure 5-43. Results of normality test on the Areas and Outliers.**

Since all these p-values, for the Marida and Kurtosis tests and the Doornik and Hansen omnibus are larger than alpha 0.05, we retain the null hypothesis and consider the sample as coming from a normal distribution. Given that the Mardia and Kurtosis tests indicated that the distribution data was normal, a ONE-WAY MANOVA was completed (Figure 5-44). A MANOVA was chosen due to the test being a multivariate analysis that determines whether there are differences between independent groups with more than one dependent variable. In this case, the independent variables or groups were the designations of horizontal representation (Areas and Outliers) and the dependent variables consisted of the PC scores that were generated in the PCA representing the shape variance that was determined through a GPA. The null hypothesis is this case is that the normal distribution of shape variance will be homologous across the site despite the spatial subdivisions. The p-value for the Wilks’ lambda test p-value for the Pillai trace test is less than 0.05 so in this case significant differences exist.
Table 5-2. Summary of MANOVA test completed for the Areas and Outliers.

<table>
<thead>
<tr>
<th>Wilks’ lambda:</th>
<th>Pillai trace:</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3959</td>
<td>0.7491</td>
</tr>
<tr>
<td>df1: 20</td>
<td>df1: 20</td>
</tr>
<tr>
<td>df2: 86</td>
<td>df2: 88</td>
</tr>
<tr>
<td>F: 2.534</td>
<td>F: 2.635</td>
</tr>
<tr>
<td>p (same): 0.001616</td>
<td>p (same): 0.001013</td>
</tr>
</tbody>
</table>

Results of the pairwise comparison illustrate the specific differences or lack thereof, between the various site areas and outliers (Table 5-2). Notably, several of the contrasts suggested visually by the convex hull plots are statistically different at the traditionally used \( p < .05 \) level.

Table 5-3. Results of the pairwise ONE-WAY MANOVA.

<table>
<thead>
<tr>
<th>OA4</th>
<th>A3</th>
<th>AC</th>
<th>A1</th>
<th>AD</th>
<th>B2</th>
<th>OA1</th>
<th>OA2</th>
<th>OA3</th>
<th>OA5</th>
<th>OA6</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.26263</td>
<td>0.29632</td>
<td>0.097664</td>
<td>0.013766</td>
<td>0.80195</td>
<td>0.31202</td>
<td>0.55944</td>
<td>0.57023</td>
<td>0.55727</td>
<td>0.26383</td>
<td></td>
</tr>
<tr>
<td>0.26263</td>
<td>0.44393</td>
<td>0.65353</td>
<td>0.06983</td>
<td>0.25006</td>
<td>0.27134</td>
<td>0.09692</td>
<td>0.59276</td>
<td>0.28742</td>
<td>0.45911</td>
<td></td>
</tr>
<tr>
<td>0.29632</td>
<td>0.44393</td>
<td>0.29299</td>
<td>0.016399</td>
<td>0.17725</td>
<td>0.43667</td>
<td>0.16569</td>
<td>0.55283</td>
<td>0.44292</td>
<td>0.37243</td>
<td></td>
</tr>
<tr>
<td>0.097664</td>
<td>0.65353</td>
<td>0.29299</td>
<td>0.23693</td>
<td>0.066405</td>
<td>0.31929</td>
<td>0.20008</td>
<td>0.40132</td>
<td>0.59053</td>
<td>0.46055</td>
<td></td>
</tr>
<tr>
<td>0.013766</td>
<td>0.06983</td>
<td>0.016399</td>
<td>0.23693</td>
<td>0.0046943</td>
<td>0.15972</td>
<td>0.0095705</td>
<td>0.07922</td>
<td>0.07077</td>
<td>0.2617</td>
<td></td>
</tr>
<tr>
<td>0.80195</td>
<td>0.25006</td>
<td>0.17725</td>
<td>0.066405</td>
<td>0.0046943</td>
<td>0.20008</td>
<td>0.28891</td>
<td>0.65495</td>
<td>0.2793</td>
<td>0.1368</td>
<td></td>
</tr>
<tr>
<td>0.31202</td>
<td>0.27134</td>
<td>0.43667</td>
<td>0.31929</td>
<td>0.15972</td>
<td>0.20008</td>
<td>0.40132</td>
<td>0.59053</td>
<td>0.46055</td>
<td>0.35375</td>
<td></td>
</tr>
<tr>
<td>0.55944</td>
<td>0.09692</td>
<td>0.16589</td>
<td>0.045576</td>
<td>0.0095705</td>
<td>0.28891</td>
<td>0.40132</td>
<td>0.39635</td>
<td>0.52335</td>
<td>0.18708</td>
<td></td>
</tr>
<tr>
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<td>0.59276</td>
<td>0.55283</td>
<td>0.39202</td>
<td>0.07922</td>
<td>0.65495</td>
<td>0.59053</td>
<td>0.39635</td>
<td>0.44178</td>
<td>0.34444</td>
<td></td>
</tr>
<tr>
<td>0.55727</td>
<td>0.28742</td>
<td>0.44292</td>
<td>0.19739</td>
<td>0.07077</td>
<td>0.2793</td>
<td>0.48055</td>
<td>0.52335</td>
<td>0.44178</td>
<td>0.60994</td>
<td></td>
</tr>
<tr>
<td>0.26383</td>
<td>0.45911</td>
<td>0.37243</td>
<td>0.50085</td>
<td>0.2617</td>
<td>0.1368</td>
<td>0.35375</td>
<td>0.18708</td>
<td>0.34444</td>
<td>0.60994</td>
<td></td>
</tr>
</tbody>
</table>

These significant differences are bolded and under scored on Table 5-3, while the differences significant at the \( p < .1 \) level are bolded and italicized. Outlier Area 2 and Area A1, despite being located adjacent to one another (Figure 4-10) are significantly different from each other, which corresponds with the CVA analysis. However, the main difference is that the Area D points are different from those in Outliers 2 and 4 and Areas C and B2. The contrast with C is especially notable since that area has the largest and most variable plotted sample and yet, Area D is different – this is despite the fact they are spatially adjacent to one another at the site (Figure 4-10). Given the difficulties in recognizing micro-patterning in small samples at these sites stressed at the outset of this discussion, it is at least worth noting that Area D also registers as possibly different at a \( p < .1 \) level from Outliers 3 (\( p = .0792 \)) and 5 (\( p = .0707 \)) and Area A3 (\( p = .0698 \)) (bolded and italicized contrasts on Table 5-3). Area D is quite different from most other areas.
However, spatial units that appear visually distinctive in convex hull plots, such as Outliers 3 and 4, do not contrast statistically with other areas except for Area D. There are several visually obvious areas overlapping Area C in the convex hull plots (Figure 5-42) and not surprisingly, the resulting statistical tests (Table 5-3), suggest that there is no substantive difference between Area C and Area1, Area A3, Area B2, and Outlier Areas 1, 2, 5 and 6 indicating they are somehow more closely related or more basically, have a similar range of point forms. That Area C overlaps or encompasses those other areas is also consistent with the range of variation it exhibits perhaps suggesting it is an occupation area used at the same time(s) or by the same individuals using the other areas.

The patterning as illustrated in the CVA and supported by the One-Way MANOVA test indicates that there is patterning with respect to the shape variation in spatial terms. The meaning of that patterning is discussed in the next section.

5.5 Discussion

The horizontal spatial analysis in Chapter 4, identified five main areas and six outlier areas across the Mackenzie I site. Physical inspection of the basal portions of the projectile points recovered from these highlighted areas suggested limited or restricted morphological variation across the whole assemblage. The morphological variation at Mackenzie I was driven, in part, by flat or concave basal apexes combined with various types of medial lateral edge shapes along the basal portions of the point.

The PCA scores, obtained from the General Procrustes Analysis (GPA) on both the Areas and Outlier Areas were used to complete a Canonical Variates Analysis (CVA) which visually highlighted potentially significant aspects of variation by area across the site. Points in Area C exhibit the most variation and that range of variation overlaps considerably, albeit to varying degrees with shape variation from Areas A1, Area A3, Area B2, and Outlier Areas 2 and 6. Most notably, however, the CVA also highlighted potentially significant differences in shape variation between Area D, and Outlier Areas 2, 3 and 4, from most of the other areas identified by the GIS analysis.
A One-Way MANOVA test supports the results of the CVA, reinforcing the results that many of the areas across the site shared similar shape variation, except for Area D and Outlier Areas 3 and 4. The projectile point assemblage of Area D is the second largest concentration of projectile points (n=7) used in the density analysis. Yet, despite that sample size, it differs significantly from most of the clusters at the south site end, including not only the most variable area sample from Area C but also Outliers 2 and 4 and Area B2. Three of those areas (Area C and Outliers 2 and 4) are spatially located only 10 to 15 m away from Area D. Only Outlier Area 3 which appears somewhat distinct visually from Area D on the CVA, is not significantly different at the .05 level from Area D. It is also of note that while Outlier Areas 2, 3 and 4 appear visually distinctive from most other areas and each other, they are not different at the .05 level from other areas. The one exception is that Outlier 2 is different from Area A1, perhaps surprising as those two locations are spatially situated right beside one another.

Overall, the real main difference is the contrast between Area D and several other southerly located areas with minimal differences between the rest of the areas, and why its point assemblage differs from that of other areas is the focus of discussion here. There are three immediately obvious potential reasons for the Area D contrasts with the southern areas.

First, Area D could represent a special activity/work area that was used at the same time as the other areas with which it contrasts but involved the discard of a functionally different “points” than those of the other areas; contemporaneous functional/activity variation accounts for the contrast between this and certain other areas. A plausible functional difference is that the Area D points were designed to be used say as knives whereas the points from the contrasting areas were used as say projectile tips or vice versa.

This scenario does not seem likely considering all the other areas consisted of discarded broken points, both bases and complete examples. Additionally, the points used in the analyses from the main concentration Areas C and D are dominated by bases lacking tips. The presence of such fragments has long been suggested to represent actual hafting or re-hafting rather than use. They represent items that were broken elsewhere and brought
back to the areas to carry out that mounting of new specimens in handles or hafts. While this idea is usually applied to projectile tips, which are used and broken away from occupation sites (Roberts 1935:21), one could at least entertain the idea that the same would apply to other hafted tools such as scrapers or knives (e.g., Keeley 1982:802-803). In this case however, it would have to be assumed that these items were brought back and deposited in separate areas, creating the appearance of functionally different areas.

Finally, if Area D was a functionally different area, it would be expected that associated artifact finds might support this notion. In examining the surrounding recoveries, however, there is no indication of such support for this idea (see Figures 4-10, 4-11). As can be seen in Figures 5-44, 5-45 and as summarized on Table 5-4, there is an abundance of the other major artifact categories recovered from Area D suggesting a wide range of activities occurred there.

Figure 5-44. Total number of recovered tools from Areas and Outlier point clusters.
In comparison to the other areas, it appears as if Area D was more of a general occupation loci rather than a specialized one. Supporting this conclusion is the results of the GIS Kernel density spatial analyses of the same artifact categories and flaking debris within these areas (Figures 4-10, 4-11). There is clearly greater clustering of several other categories of artifacts in the exact same spatial area as Area D, whereas that is not the case in the adjacent Area C (see Table 5-4, Figures 4-10 and 4-11). Notably, Area C yielded the highest absolute recoveries of basal forms, the points recovered do not differ much from the ones in several other areas, and the points recovered exhibits the broadest overall morphological variation across the site. These characteristics suggest Area C could represent a somewhat specialized, perhaps communal, work area where broken points were refitted and/or rehafted used at the same time by the same individuals.

**Figure 5-45. Percentages of recovered tools from Areas and Outlier point clusters.**
In summary, recoveries from Area D consisted of various other artifact forms as well as concentrations of primary and secondary debitage debris. Given these finds and the results of the CVA and MANOVA analysis, the distinctiveness of this area is most likely to reflect other sources of non-functional variation.

If a functional difference seems unlikely, a second potential explanation for the differences in shape variation between Area D and several others can be made. It is possible that the differences highlighted by the CVA and MANOVA represent a contrast in idiosyncratic/social terms among the site occupants. This kind of evidence of different individuals or, given the small size of Area C, something such as an extended family group, need not be intentional. It is possible, for example, that one would learn flint-knapping largely from observation and teaching of closer relatives so would share more in common with those closer social ties than with other comparable social units or with individuals in those other comparable social units.

The idea that contemporaneous idiosyncratic or social differences can be measured between areas such as Area D and Area C is hard to evaluate in any substantive manner.

<table>
<thead>
<tr>
<th>Area</th>
<th>Bifaces</th>
<th>Knives</th>
<th>Drills</th>
<th>Scrapers</th>
<th>Primary Debris</th>
<th>Secondary Debris</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area A1</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
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</tr>
<tr>
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<td>-</td>
<td>+</td>
<td>+</td>
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<td>-</td>
</tr>
<tr>
<td>Area B2</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Area C</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Area D</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Outlier Area 1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
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<td>-</td>
<td>+</td>
<td>+</td>
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<td>Outlier Area 3</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Outlier Area 4</td>
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<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
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<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
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<tr>
<td>Outlier Area 6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

+: Area has high Kernel Density and clustering of that artifact form.
-: Area has low Kernel Density and clustering of that artifact form.
Underlined Spatial Cluster: Areas of relatively distinct and clustered point forms.
However, the argument that Area C may be a somewhat specialized work area and that it was used by several people (as evidenced by the wide variation in point forms), yet differs in point variation from Area D, suggests idiosyncratic or social factors may not actually be accounting for the contrast between the two. Also, some Paleoindigenous site analyses (e.g., Deller and Ellis 1992; Wilmsen 1970), suggest there may be minute differences between manufacturing methods of individuals or between larger social units such as bands, the variation would likely appear more continuous rather than as a marked contrast as is suggested in the MANOVA results. Indeed, from a theoretical perspective, Paleoindigenous groups are often seen as small, low-density populations, and especially since they were involved in moving into new expansive areas that had no existing populations or are only shorter-term occupations following ice and lake level retreats. In such circumstances, and especially given the type of environments whereby resources would be widely dispersed, maintaining social ties that can be drawn upon for aid and assistance in times of resource shortages or to maintain a demographically viable population become very important (e.g., MacDonald 1998; Mandryk 1993; Wobst 1976). In these types of situations, there are strong pressures to maintain stylistic homogeneity amongst such groups (e.g., Ellis 1989:156; Weissner 1983). Hence, it could be argued that the marked differences between the Area C and D points are not likely to be a product of idiosyncratic or social differences.

In addition, the idea that one would learn only from one’s closest relatives seems unlikely in these smaller scale societies where there is frequent population fission and fusion and shifting of local group affiliation. Some argue people are often just as likely to imitate or learn from more successful individuals rather than simply one’s immediate relatives (e.g., O’Brien et al. 2016). One might suggest that the points are so different morphologically at Area D from the other areas yet are almost spatially congruous to it that a stronger argument can be made that the morphological variation is due to primarily another factor discussed below, namely, micro-temporal differences.

One other aspect which might suggest social/idiosyncratic differences is the presence of what could be considered “exotic raw materials” recovered at the site. One could argue that areas with more or different raw materials indicates the presence of individuals who, unlike the users of other areas/outliers, had access to those cherts. Such an argument has
been made to suggest such differences between apparently contemporaneously used areas at the Thedford II fluted point site in southern Ontario where only one area had an exotic material in some quantity (Deller and Ellis 1992). At the Mackenzie 1 approximately 98% of the material assemblage recovered consisted of Taconite, Siltstone, Cherts and Quartz, all native materials found within northwestern Ontario. Of note, however, is also the presence of Hixton Silicified sandstone which, as noted earlier, is a raw material found only in a small area at Silver Mound, Wisconsin, and utilized by Paleoindigenous groups within the region (Hill 1994; Ross 1995). Ross (1995:257) notes the rarity of Hixton within northwestern Ontario. Nonetheless, the presence of Hixton in very low frequencies at several Paleoindigenous sites from Rainy River to Thunder Bay (Ross 1995:257) illustrates a connection between the Lake Superior Basin area and Wisconsin. Recoveries from the Mackenzie site, however, include the largest frequency of Hixtondebitage and tools within the region and when plotted horizontally across the site do suggest an interesting and potentially significant pattern (Figure 5-46).
Areas D and A1 seem to have the highest concentration, while Outliers 1, 3, and 4 have less but still more than the odd example. The remaining areas do not have any Hixton or a single example, namely Areas C, B2, A3 and Outliers 2 and 6. Areas that have
statistically different shape variation from Area D include Areas B2, Area C and Outlier Areas 2 and 4 (Figure 5-46; Table 5-5). Conversely, clusters that are not statistically different pairwise with regards to shape variation found in Area D include Areas A1 and Outlier Areas 1 and 3. In sum, most areas without Hixton contrast with Area D in that they have a somewhat different point sample, Outlier 4 being an exception. As there are multiple areas with this contrast, and unlike the single area contrast seen at the Thedford II site, the contrast is seemingly more pervasive, which would make it unlikely this contrast is a simple social/idiosyncratic difference between Area D and the other areas.

Table 5-5. Hixton Raw Material by Site Area/Outlier.

<table>
<thead>
<tr>
<th>Location</th>
<th>Hixton</th>
<th>No Hixton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area A1</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Area A3</td>
<td>X*</td>
<td></td>
</tr>
<tr>
<td>Area B2</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>Area C</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>Area D</td>
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</tr>
<tr>
<td>Outlier 1</td>
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<td>Outlier 2</td>
<td>S</td>
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</tr>
<tr>
<td>Outlier 3</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Outlier 4</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>Outlier 5</td>
<td>X*</td>
<td></td>
</tr>
<tr>
<td>Outlier 6</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

Point samples: S: statistically significant at the 0.05 level; X*: statistically significant at the 0.1 level; X: no significant differences.

The distribution of Hixton could represent changes in its use over time. In other words, there were changes in long-distance interaction or movement patterns over time, which resulted in lesser or fewer Hixton artifact being present. As discussed later, the only Hixton point from the site more closely resembles Cody Complex point forms from Wisconsin, which may date earlier in the overall occupation of the site, perhaps suggesting Area D and its confreres date earlier than most other areas/outliers. Indeed, perhaps the strongest overall argument to account for the contrasts between point cluster areas is that they represent micro-temporal differences between Area D and the other areas. Time would not be the cause of the actual differences seen, just that the longer the
time depth of site use, the more time various processes of temporal change would have been in operation. Processes such as unintentional cultural drift, shifts to take advantage of some superior functional change in weapon systems, etc., are all potentially causative mechanisms for the observed temporal variation (e.g., O’Brien et al. 2016). In this scenario, the same location could be used over some period of time with the Area D differences representing an earlier or later occupation of the same location. Reoccupation of site locations, often even for different purposes, is well documented ethnographically (e.g., Binford 1982:12-17; Jochim 1991). Many larger Paleoindigenous sites in the Northeast have smaller associated “satellite” sites or site areas which could represent later or earlier occupations (Spiess and Wilson 1987:135; Spiess, Wilson and Bradley 1998:231) and even Mackenzie I is near other sites such as Newton and Woodpecker 1 and 2. Notably, in her spatial analysis of the material within Area D (call Area East), McCulloch (2015:279) detected some sub-clustering. Although she suggested the area might represent multiple events, it was noted that those sub-clusters, some of which were refuse piles in secondary contexts, were interconnected as indicated by artifact refits and hearth features. Such spatial organization and consistent use of space does suggest the area might represent a shorter time of use overall and would be more consistent with a distinct period of occupation.

Even accepting micro-temporal differences, unfortunately, in the absence of multiple dates and any stratigraphic information from the site it is difficult to document the sequence of occupations. Under the above interpretation, Area A1 and Area A3 would probably have been used at the least partially at the same time as Area C given the points samples are similar, and by larger numbers of people given the wide range of artifact recoveries (Figure 5-44 and 5-45; Table 5-4). Also, Areas A1 and A3 appear to have the highest concentration of what are considered habitation site artifacts such as knives, drills, scrapers, and retouched flakes (Figures 5-44 and 5-45; Table 5-4). These areas were likely utilized primarily and extensively over the duration of all occupations at the site. The clustering of different artifact forms within different parts of these areas also suggests a long and complex occupation history. The lack of significant differences between Areas A1 and A3 with the Area D point examples (Figure 5-45), could suggest Area D was also used for a time when the Area A locations were also being occupied.
Being situated adjacent to what is now known as the Mackenzie I river, these areas would have had primary access to sustainable resources, such as waterfowl, plants, fish, and terrestrial animals as well as using the river for water.

To a lesser extent Area B2 has higher concentrations of a variety of tools but is situated closer to the southern portion of the site. It is possible that this area could have been one of the last areas utilized at the site as it could have been situated adjacent to water of glacial Lake Minong and a river-mouth area. Located on the lowest elevation, it could have been used and abandoned as waters of Lake Minong retreated south or perhaps was a less well drained, less suitable area to camp given the more recent retreat of those lake waters. Unfortunately, the lack of dates and stratigraphy at the site do not allow for confirmation of this assumption, it is merely based on geological attributes of the site. However, Area D does not contrast point wise with more southern site located Outlier 3 and is inconsistent with the idea there is a time spatial shift associated with increasing accessibility of the south site end. Moreover, the larger concentrations of Hixton in the same southern area, if due to shifting and perhaps lesser access to that exotic source over time, seems to contradict that argument too.

5.6 Summary of Intra-Site Analysis

The ArcGIS tools that were employed to complete the horizontal spatial analysis, supplemented by other information, identified five cluster areas and six outlier areas across the Mackenzie I site. Physical examination of projectile points from the Areas and Outliers suggested limited morphological variation with most of it due to basal edges being either flat or concave in form. Utilizing the PCA scores from a GPA, a Canonical Variates Analysis was completed, highlighting major overlap among and within points from Areas A1, Area A3, Area C, Area B2, Outlier Area 1, Outlier Area 2, and Outlier Area 6. Nonetheless, major differences were revealed largely between Area D and several other areas. A One-Way MANOVA test was completed which supported the results of the CVA reinforcing the fact that Area D has significant shape variation from the other areas. While hard to reach a definitive conclusion, it seems that the differences between Area D from Area C are measuring a micro-temporal shift of area use during the occupations. That being the case, morphometric analyses could be very useful in better
understanding site occupation histories. Certainly, such ideas are worth exploring in future studies at other sites.

The shape variation within the major areas (Areas A1, Area A3) is most likely representing similar social groupings of people making similar point styles to an extent that statistically they overlap or plot close together. Area C may be a more specialized work area associated with/used at the same time as A1, A3 and other areas where an emphasis was on point re-hafting. Due to the broad variation that exists in that area, it is plausible that this location was used repeatedly by similar people making similar types of points who also used other site areas at the same time. These other areas are not considered specialized work locations, but rather differences due to micro-temporal use of the site. Despite these points appearing similar enough to the naked eye, at a micro-morphological level they are different enough that the 3D Geometric Morphometric analysis has revealed the minute distinctions between them. In sum, the differences between the points from different areas are quite subtle and not easily detected visually and probably also would be extremely difficult to detect with grosser linear measurements or simply attribute based comparisons and clearly would be beyond typological analyses.

From a site occupation perspective, it’s worth noting that the distribution of artifacts from the Mackenzie I site is 10,000 m². From north to south as well as east to west, the site ranged 100 m and is located on the west side of the Mackenzie River. Such a size and horizontal distribution of artifacts, and the presence of random patterning in the arrangement and spacing of the different site areas/outliers, a patterning which is often used to argue for contemporaneity (e.g., Deller and Ellis 1992; Robinson et al. 2009; Spiess 1984) reinforces the idea that the site was re-occupied several times.

Given the size and location of the site, situated adjacent to significant water bodies (the Mackenzie River to the east and Lake Minong to the south) the depositional environments of the soils might reveal some indication of possible antiquity or sequence of occupation. Shultis (2013:211) notes that the northern portion of the site represent beach sands, although one stresses that all the artifacts came from bioturbated deposits. Nonetheless, there is the possibility that artifacts recovered in these locations represented beach occupations on the active shore of Lake Minong. As the waters of Lake Minong
retreated, the depositional environment changed, and the southern portion of the site deposits represent a river-mouth depositional environment (Shultis 2013:211). This could mean that the landscape surrounding the mouth of the Mackenzie River was altered as the waters of Lake Minong retreated. The types of environments changed over time as illustrated by the deposition of the soils, but when considering the variation in projectile points between the areas, the narrative becomes more complex. The variation that separates Area D, being the northern most Area (as defined earlier) of projectile point concentration, could represent micro-temporal shifting areas of use with an early use during the overall occupation. As one moves south across the site, the other areas and outlier areas could be a representation of later occupations as evidenced by the deposits and the changing environment with Outlier Area 3 being one of the last occupied areas of the site. However, there is contradictory evidence in the areal point variation and use of Hixton that leads one to question that scenario. Also, Markham (2013:223) detected no evidence of consistent changes in points from north to south and that scenario can be questioned based on a consideration of point typological comparisons. That evidence will be considered in Chapter 7.
Chapter 6

6 Regional Comparisons

In this chapter, the analyses switch to a broader level to examine the Mackenzie I site assemblage in the context of points from Northwestern Ontario, Manitoba, and Minnesota. The specific regions with comparative point data that were chosen for this research were based mainly on availability and ease of access. Efforts were made to obtain information from areas further afield such as North and South Dakota and Wisconsin, but due to limitations in time, funding and more recently, liabilities of crossing an international border, obtaining that data was precluded. The somewhat unsystematically accessed comparative collections were obtained from mid-western Manitoba in the Swan River region, northern Minnesota, and northwestern Ontario (Figure 6.1).

The overall comparative sample employed here totals 221 projectile point bases of which 54% (n=119) of them are the Mackenzie I site recoveries (and associated Woodpecker site examples). Samples from the other areas breakdown as 11% (n=24) from Manitoba, 11% (n=24) from Minnesota, and 24% (n=53) from various areas in northwestern Ontario. Figure 6.1 highlights the geographic locations of the comparative projectile point samples employed in this research.

While the samples even within regions can vary considerably, as stressed earlier, the present research was intended as an exploratory study to see if there were any overriding general similarities and differences between the points from various areas, how Mackenzie I fits in with the other samples previously reported and what that may reveal about the representativeness of existing samples. As well, it is important to begin developing a 3D GM data base that might be used or built upon in other future studies. Hence, any type that was either considered to be Plano or Paleoindigenous in nature was scanned in and used as a comparison. The following sections discuss in more detail the nature of the comparative samples used in this research.
6.1 Manitoba Sample

The 24 points in the Manitoba sample all came from an area west of the former pro-glacial Lake Agassiz basin discussed in Chapter 2. Data for these samples were obtained for research via a private collector who has registered the finds with the Manitoba provincial Heritage Branch. On that west side of Agassiz, the influx of waters from several glacial lakes poured into the greater lake. Glacial waters from several spillways and channels from smaller pro-glacial lakes such as Lake Regina, Lake Souris, Lake Assiniboine, Lake Saskatchewan as well as the Assiniboine Delta emptied into glacial Lake Agassiz creating and modifying the landscape in the form of rivers and larger bodies of water (Figure 6-2).
Points from the Manitoba sample were found between the Porcupine Mountains in the north and Duck Mountains in the south along the western edge of what would have been glacial Lake Agassiz (Figure 6-3). Samples are all surface finds with most finds (79%; n=19) being obtained mainly from the Upper Campbell strandline (Figures 6-2 and 6-3) with a few (12%; n=3) being recovered from just below that level and one being found on the strandline itself (Figure 6-3). Those below that strandline therefore must date after that strandline or <9500 RCYBP as none are waterworn. Of course, the items found above the Campbell level could be older.
The Borden designations of sites that were used are EcMg, EhKr, ElMi, FaKa, FaMd, FaMh, FaMj, FcMi and FcMg. Most of the samples from Manitoba consist of lateral edges that taper down to the base (Figure 6-4). Basal edges of the samples appear either flat or concave to a small degree with lateral basal grinding present on most of the samples (Table 6-1). There is very little evidence of parallel flaking on the surface of the points with many of them appearing to have a randomized flaking pattern.

From the sample used, 69% of the points have the general random flaking on the surface while the remaining 31% have some degree of parallel-oblique flaking. The degree of parallel-oblique flaking ranges from at least one flake scar to many, and the percentage of parallel-oblique flaked points with concave bases is equal to that of parallel-oblique and
flat based points. For this research, a single parallel flake scar is evidence of more on the blade, even if the point was broken. Given the intentional nature of parallel-oblique flaking, it isn’t something that is “accidental” or unintentional in its appearance.

Table 6-1. Morphological traits of the points used from the Manitoba samples.

<table>
<thead>
<tr>
<th>Catalogue #</th>
<th>CS</th>
<th>Cultural Affiliation</th>
<th>Lateral Edges</th>
<th>Flaking</th>
<th>Basal Shape</th>
<th>Lateral Edge Grinding</th>
</tr>
</thead>
<tbody>
<tr>
<td>FcMg-76</td>
<td>Below</td>
<td>Nipawin Complex</td>
<td>Tapered</td>
<td>Random</td>
<td>Rounded</td>
<td>Present</td>
</tr>
<tr>
<td>ElMj-1</td>
<td>Above</td>
<td>Nipawin Complex/Agate Basin</td>
<td>Tapered</td>
<td>Random</td>
<td>Convex</td>
<td>Present</td>
</tr>
<tr>
<td>ElMj-38-5</td>
<td>Above</td>
<td>reworked Cody</td>
<td>Straight</td>
<td>Random</td>
<td>Concave</td>
<td>Present</td>
</tr>
<tr>
<td>ElMj-28-2</td>
<td>Above</td>
<td>Nipawin Complex</td>
<td>Straight</td>
<td>Random</td>
<td>Concave</td>
<td>Present</td>
</tr>
<tr>
<td>ElMj-29</td>
<td>Above</td>
<td>Cody Complex</td>
<td>Straight</td>
<td>Random</td>
<td>Flat</td>
<td>Present</td>
</tr>
<tr>
<td>ElMj-35</td>
<td>Above</td>
<td>Nipawin Complex/Agate Basin</td>
<td>Tapered</td>
<td>P/O</td>
<td>Flat</td>
<td>Present</td>
</tr>
<tr>
<td>ElMj-40</td>
<td>Above</td>
<td>Nipawin Complex/Agate Basin</td>
<td>Tapered</td>
<td>Random</td>
<td>Flat</td>
<td>Present</td>
</tr>
<tr>
<td>FaMd-3</td>
<td>On</td>
<td>Nipawin Complex</td>
<td>Tapered</td>
<td>P/O</td>
<td>Concave</td>
<td>Present</td>
</tr>
<tr>
<td>FaMh-2</td>
<td>Above</td>
<td>No point photo</td>
<td>Tapered</td>
<td>Random</td>
<td>Flat</td>
<td>Present</td>
</tr>
<tr>
<td>FaMh-3</td>
<td>Above</td>
<td>Nipawin Complex</td>
<td>Tapered</td>
<td>P/O</td>
<td>Concave</td>
<td>Present</td>
</tr>
<tr>
<td>FaMj-1-5</td>
<td>Above</td>
<td>Plano?</td>
<td>Straight</td>
<td>Random</td>
<td>Concave</td>
<td>Not Noted</td>
</tr>
<tr>
<td>FaMj-1-9</td>
<td>Above</td>
<td>Nipawin Complex</td>
<td>Tapered</td>
<td>Random</td>
<td>Concave</td>
<td>Present</td>
</tr>
<tr>
<td>FbMh-29</td>
<td>Below</td>
<td>Nipawin Complex</td>
<td>Tapered</td>
<td>Random</td>
<td>Flat</td>
<td>Present</td>
</tr>
<tr>
<td>FbMi-61</td>
<td>Above</td>
<td>Goshen/Nipawin Complex</td>
<td>Straight</td>
<td>P/O</td>
<td>Concave</td>
<td>Present</td>
</tr>
<tr>
<td>FeMg-55-2</td>
<td>Below</td>
<td>Nipawin Complex</td>
<td>Tapered</td>
<td>Random</td>
<td>Concave</td>
<td>Present</td>
</tr>
<tr>
<td>FeMg-55-3</td>
<td>Below</td>
<td>Nipawin Complex</td>
<td>Tapered</td>
<td>Random</td>
<td>Flat</td>
<td>Present</td>
</tr>
<tr>
<td>Md_1041</td>
<td>Above</td>
<td>Goshen/Nipawin Complex</td>
<td>Tapered</td>
<td>Random</td>
<td>Concave</td>
<td>Not Noted</td>
</tr>
<tr>
<td>Md_958</td>
<td>Above</td>
<td>Nipawin Complex</td>
<td>Tapered</td>
<td>Random</td>
<td>Convex</td>
<td>Not Noted</td>
</tr>
<tr>
<td>Md_684</td>
<td>Above</td>
<td>Plano</td>
<td>Straight</td>
<td>Random</td>
<td>Flat</td>
<td>Present</td>
</tr>
<tr>
<td>Sr09-1</td>
<td>Above</td>
<td>Nipawin Complex</td>
<td>Tapered</td>
<td>P/O</td>
<td>Flat</td>
<td>Present</td>
</tr>
<tr>
<td>Sr90-1</td>
<td>Above</td>
<td>Nipawin Complex</td>
<td>Tapered</td>
<td>P/O</td>
<td>Flat</td>
<td>Present</td>
</tr>
<tr>
<td>Sr96-1</td>
<td>Above</td>
<td>reworked Cody</td>
<td>Straight</td>
<td>P/O</td>
<td>Flat</td>
<td>Present</td>
</tr>
<tr>
<td>Sr96-5</td>
<td>Above</td>
<td>Cody</td>
<td>Straight</td>
<td>Random</td>
<td>Flat</td>
<td>Present</td>
</tr>
<tr>
<td>Sr96-6</td>
<td>Above</td>
<td>Plano</td>
<td>Straight</td>
<td>P/O</td>
<td>Concave</td>
<td>Present</td>
</tr>
</tbody>
</table>

P/O=Parallel-Oblique; CS = Campbell Strandline

The material on which the points are made are predominately local sourced Swan River chert that is generally found in cobble form across the province. Most of them were classified by the researcher as “Nipawin Complex,” with possible Goshen and Scottsbluff (Cody Complex) point type examples included. The Nipawin Complex was a term introduced by David Meyer (1970) to encompass the finds from Carrot River of eastern Saskatchewan and northwestern Manitoba. It was a reaction to earlier researchers who had classified many lanceolate forms as Agate Basin. Meyer (1970) argued that the Manitoba sites much post-dated the appearance of Agate Basin and differed in technological and morphological details from that Plains form. Morphological differences of the “Nipawin” forms included a wider range of basal outlines, slightly thicker mid-
sections, and the presence of asymmetrical forms. These contrasted with the Agate Basin forms that have narrow basal ends, which are either rounded, flat or slightly concave, thinner mid-sections and are symmetrical in appearance. As a general lanceolate form, they appear at roughly the same times as Lovell Constricted, Angostura, Lusk and other general lanceolate forms and are considered to be precursors of what has been called the Caribou Lake complex, a Manitoba development characterized by yet other Agate Basin reminiscent lanceolate forms (Pettipas 2013). On geological grounds all such typological identifications are possible and, as noted in Chapter 2, definitive finds of all such types, even the ones dated to pre-10,000 RCYBP like Agate Basin, have been made in adjacent areas to the west and south away from the Agassiz strandlines. However, the forms with parallel-oblique flaking would seem to date later than those other forms as will be discussed more below and in Chapter 7.

6.2 Minnesota Sample

The sample obtained from sites in Minnesota included any points that were identified or classified by previous researchers as Late Paleoindigenous. Unfortunately, only a small sample (n=24) could be obtained, and these were exclusively from the northern portion of the state. Much of the sample was obtained from the Superior National Forest (N=14), which has a Heritage program and Archaeological Support Staff that conduct heritage resource management within the boundaries of the forest. A portion of the sample was obtained from the Duluth Archaeological Centre (n=5), a cultural resource management consulting company who specialize in both archaeology and geomorphology. Finally, a small sample (n=5) was obtained from avocational collectors during the Lake Superior Basin workshop, which is a gathering of both professional archaeologists and collectors from northwestern Ontario, Minnesota, and Wisconsin. The main objective of the workshop is to share relevant information regarding archeology across the international border, promote cultural resources and to directly examine physical artifacts rather than present academic papers.

The points range in size, but all are considered lanceolate in shape with 66.6% of the lateral edges being tapered, 37% of the flaking pattern being parallel-oblique and 63% of
the basal edges being concave (see Table 6-2). Basal lateral grinding was noted on 58.3% of the sample.

Table 6-2. Morphometric attributes of the points from Minnesota.

<table>
<thead>
<tr>
<th>Point</th>
<th>Lateral Edges</th>
<th>Flaking Pattern</th>
<th>Basal shape</th>
<th>Basal Lateral Grinding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beach Balls</td>
<td>Tapered</td>
<td>Random</td>
<td>Concave</td>
<td>Not Present</td>
</tr>
<tr>
<td>Beer can</td>
<td>Tapered</td>
<td>Random</td>
<td>Concave</td>
<td>Not Present</td>
</tr>
<tr>
<td>Flatt</td>
<td>Tapered</td>
<td>Random</td>
<td>Flat</td>
<td>Present</td>
</tr>
<tr>
<td>Grpo-20923</td>
<td>Tapered</td>
<td>Random</td>
<td>Concave</td>
<td>Not Present</td>
</tr>
<tr>
<td>Grpo-20929</td>
<td>Straight</td>
<td>Random</td>
<td>Concave</td>
<td>Present</td>
</tr>
<tr>
<td>Langdahla</td>
<td>Straight</td>
<td>Random</td>
<td>Concave</td>
<td>Present</td>
</tr>
<tr>
<td>Lf1</td>
<td>Tapered</td>
<td>Concave</td>
<td>Concave</td>
<td>Present</td>
</tr>
<tr>
<td>Lf2</td>
<td>Straight</td>
<td>P/O</td>
<td>Concave</td>
<td>Present</td>
</tr>
<tr>
<td>Lf3</td>
<td>Tapered</td>
<td>P/O</td>
<td>Concave</td>
<td>Present</td>
</tr>
<tr>
<td>Lf4</td>
<td>Straight</td>
<td>Random</td>
<td>Concave</td>
<td>Not Present</td>
</tr>
<tr>
<td>Lf5</td>
<td>Tapered</td>
<td>Random</td>
<td>Flat</td>
<td>Present</td>
</tr>
<tr>
<td>sf-02-033</td>
<td>Tapered</td>
<td>Random</td>
<td>Concave</td>
<td>Present</td>
</tr>
<tr>
<td>sf-02-633-959</td>
<td>Straight</td>
<td>Random</td>
<td>Flat</td>
<td>Not Present</td>
</tr>
<tr>
<td>sf-03-043-14</td>
<td>Tapered</td>
<td>Random</td>
<td>Flat</td>
<td>Not Present</td>
</tr>
<tr>
<td>sf-05-264</td>
<td>Tapered</td>
<td>P/O</td>
<td>Concave</td>
<td>Present</td>
</tr>
<tr>
<td>sf-05-404-5</td>
<td>Tapered</td>
<td>Random</td>
<td>Flat</td>
<td>Not Present</td>
</tr>
<tr>
<td>sf-09-05-170</td>
<td>Tapered</td>
<td>P/O</td>
<td>Flat</td>
<td>Not Present</td>
</tr>
<tr>
<td>sf-09-344-2</td>
<td>Tapered</td>
<td>P/O</td>
<td>Concave</td>
<td>Present</td>
</tr>
<tr>
<td>sp-02-239-12b</td>
<td>Straight</td>
<td>Random</td>
<td>Flat</td>
<td>Not Present</td>
</tr>
<tr>
<td>sp-02-31-5</td>
<td>Tapered</td>
<td>Random</td>
<td>Concave</td>
<td>Present</td>
</tr>
<tr>
<td>Sp-02-632-84</td>
<td>Slightly Flared</td>
<td>P/O</td>
<td>Concave</td>
<td>Present</td>
</tr>
<tr>
<td>sp-02-655-5</td>
<td>Tapered</td>
<td>P/O</td>
<td>Concave</td>
<td>Present</td>
</tr>
<tr>
<td>sp-03-042-14</td>
<td>Tapered</td>
<td>P/O</td>
<td>Flat</td>
<td>Not Present</td>
</tr>
<tr>
<td>sp-04-034-105</td>
<td>Straight</td>
<td>P/O</td>
<td>Flat</td>
<td>Present</td>
</tr>
</tbody>
</table>

Generally, there were no existing typological designations for the points that were used. They were all considered to be Paleoindigenous types, and most were classified simply as general lanceolate types (see Figure 6-5 for a representative sample) but as can be seen they closely resemble in outline shape and flaking the Mackenzie I sample. Certainly, some could be classified quite easily into certain types. For example, SP-020632-84 (Figure 6-5 far right) is an example of a type in the area mentioned earlier as “Minoqua”, a smaller lanceolate form with a stem and eared basal corners. These types have been linked by some to Scottsbluff (Cody Complex) forms found in Minnesota and Wisconsin (Ross 1995), but the parallel-oblique flaking is not a Scottsbluff attribute. Other items, less similar to Mackenzie I items, could be seen as Agate Basin (see Figure 6-5, LF5) or even be assigned to the concave based and serrated Dalton dated to ca. 10,000 RCYBP.
(see, for example, Goodyear 1982), a type best known to the south in the middle to lower Mississippi Valley (Figure 6-5; “Langdala”).

Figure 6-5. Some of the projectile points used from Minnesota.

6.3 Northwestern Ontario Samples

The remaining data on 50 points were obtained from several areas widespread across northwestern Ontario (NWO; Table 6-3) including Lake of the Woods (n=8), Rainy River (n=6), Dog Lake (n=5), Quetico National Park (n=3), Lac Seul (n=4) and individual sites east and west of Thunder Bay (n=24) including the Woodpecker site (n=4).

Table 6-3. Breakdown of projectile point location and totals in northwestern Ontario.

<table>
<thead>
<tr>
<th>Location</th>
<th>Total Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dog Lake</td>
<td>5</td>
<td>9.3%</td>
</tr>
<tr>
<td>Lake of the Woods/Kenora</td>
<td>8</td>
<td>14.8%</td>
</tr>
<tr>
<td>Lac Seul</td>
<td>4</td>
<td>7.0%</td>
</tr>
<tr>
<td>Interior Sites</td>
<td>24</td>
<td>44.4%</td>
</tr>
<tr>
<td>Rainey River</td>
<td>6</td>
<td>11.1%</td>
</tr>
<tr>
<td>Woodpecker sites</td>
<td>4</td>
<td>7.4%</td>
</tr>
<tr>
<td>Quetico</td>
<td>3</td>
<td>5.6%</td>
</tr>
<tr>
<td>Totals</td>
<td>54</td>
<td>100%</td>
</tr>
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</table>
The sites east of Thunder Bay area are found along the Minong shoreline area and include materials from the Cummins (n=5), Brohm (n=1) sites and Woodpecker 1 and 2 (n=4), as well as several finds from smaller sites within the Superior Basin area (n=12). Both Dawson (1983), Julig (1991, 1994), and MacNeish (1952) have completed work on these sites, but not all their recoveries were available for examination. This area corresponds to the “Lakehead Complex” location defined by others (Fox 1975, 1980; Ross 1995). The remaining finds are situated well inland from the Minong strandline/immediate Lake Superior area extending northwest of Thunder Bay all the way to near the Manitoba border will be considered “far interior sites” in later discussions Julig (1994) in his earlier comparative analyses designated them simply as “interior” sites. Indeed, some of the points used herein were included in Julig’s (1994) data base. The points examined for this study came from: the Kenora Museum, Quetico Provincial Park Museum, Dog Lake, and Lac Seul area avocational collectors who registered sites with Ontario Ministry of Heritage, Sport, Tourism and Culture Industries (MHSTCI). This sample also includes Royal Ontario Museum housed artifacts from surveys in the Rainy River region of northwestern Ontario (Figure 6-6). Points obtained for the sample were all classified previously as Paleoindigenous, so not surprisingly they are of a general lanceolate form and are made from a variety of local raw materials.

Figure 6-6. Representative sample of points from across northwestern Ontario (ROM – Rainy River area; Lac Seul – private collection; DdJt-3 – Quetico Park; DeJi-6 – Dog Lake; DbJm-6 Whitefish Lake).
The northwestern Ontario sample is highly variable with regards to morphological shape, perhaps not surprising as it comes from such a large area and one that was in some places geologically available for occupation earlier than the Mackenzie 1 area sites. Points range from long lanceolate forms that have tapering edges with slightly convex to convex bases. Typologically, some appear as more Agate Basin-like such as the Hixon example from site DdJt-3 (Figure 6-6 and that was identified as that type by Ross (1995). Hence such items are possibly early in date, but more Angostura-like forms are also present (e.g., Figure 6-6: ROM 958.196.5) that date later and parallel-oblique flaking appears on some of the specimens that are also suggestive of later dating occupations (see Table 6-4 and Chapter 7 below).

Table 6-4. Morphometric attributes of the points from Northwestern Ontario.

<table>
<thead>
<tr>
<th>Site/Name</th>
<th>Lateral Edges</th>
<th>Flaking Pattern</th>
<th>Basal Shape</th>
<th>Location</th>
<th>Basal Edge Grinding</th>
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<tr>
<td>Al point</td>
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<td>Flat</td>
<td>LOTW</td>
<td>Present</td>
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<tr>
<td>C364</td>
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<td>Parallel</td>
<td>Concave</td>
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<td>Random</td>
<td>Convex</td>
<td>RR</td>
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</tr>
<tr>
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<td>Flat</td>
<td>RR</td>
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</tr>
<tr>
<td>C372</td>
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<td>Random</td>
<td>Concave</td>
<td>RR</td>
<td>Present</td>
</tr>
<tr>
<td>DaJn-7</td>
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<tr>
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</tr>
<tr>
<td>DcJt-9-14</td>
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<td>Co-medial</td>
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</tr>
<tr>
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<td>Parallel</td>
<td>Flat</td>
<td>Quetico</td>
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</tr>
<tr>
<td>DdJt-1-6</td>
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<td>Parallel</td>
<td>Flat</td>
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</tr>
<tr>
<td>DdJi-6</td>
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<td>Random</td>
<td>Concave</td>
<td>DL</td>
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</tr>
<tr>
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<td>Flat</td>
<td>DL</td>
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</tr>
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<td>Flat</td>
<td>DL</td>
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</tr>
<tr>
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<td>Random</td>
<td>Concave</td>
<td>DL</td>
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</tr>
<tr>
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<td>Random</td>
<td>Flat</td>
<td>Quetico</td>
<td>Not present</td>
</tr>
<tr>
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<td>Flat</td>
<td>CS</td>
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</tr>
<tr>
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<td>Parallel</td>
<td>Flat</td>
<td>CS</td>
<td>Not present</td>
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<tr>
<td>Eaka-6</td>
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<td>Random</td>
<td>Flat</td>
<td>Lac Seul</td>
<td>Not present</td>
</tr>
<tr>
<td>EbJx-9</td>
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<td>Random</td>
<td>Flat</td>
<td>Lac Seul</td>
<td>Not present</td>
</tr>
<tr>
<td>F32836</td>
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<td>Random</td>
<td>Flat</td>
<td>CS</td>
<td>Not present</td>
</tr>
<tr>
<td>EaKa-33</td>
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<td>Random</td>
<td>Flat</td>
<td>Lac Seul</td>
<td>Present</td>
</tr>
<tr>
<td>GKPP</td>
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<td>Random</td>
<td>Flat</td>
<td>Lac Seul</td>
<td>Not present</td>
</tr>
<tr>
<td>Grd 02-10</td>
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<td>Random</td>
<td>Concave</td>
<td>Quetico</td>
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</tr>
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<td>Hilary PT</td>
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<td>CS</td>
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<td>KM 074</td>
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<td>Random</td>
<td>Concave</td>
<td>LOTW</td>
<td>Present</td>
</tr>
</tbody>
</table>
The distribution of basal edges from the northwestern Ontario sample consists of three forms: convex, concave, and flat. Those with concave basal forms comprise 40% (n=22) of the sample with samples that have flat edges making up 53% (n=29) and convex basal edges the remaining 6% (n=3). Flaking patterns observed in the sample ranged between random and parallel-oblique. Those that have a random flaking pattern comprise 74% (n=40) of the sample with those with parallel oblique making up 24% (n=13). There was one example with a co-medial flaking pattern.

6.4 The Mackenzie I Point Samples

Although much has been discussed with regards to the morphological traits of a selected number of the Mackenzie I points from particular spatial locations, the assemblage as a whole has not been discussed. Having been excavated in a relative controlled manner, these points all have provenience and context that many of the other point samples do not. Recovered from relic Minong shoreline areas, there is considerable variation within the assemblage, but like the other samples, and as discussed in some detail in the previous chapter, basal shape was defined by two types: flat and concave. Lateral edges consisted of either tapered towards the base, straight or “mixed”. This “mixed” variety had not been observed in other samples and is represented by one side having a straight or tapered edge and the other having a lateral edge and a bulbous rounded corner (Figure 6-7). There are approximately 25 of these types of basal forms in the Mackenzie I assemblage and 20 of them are concave. This type of basal shape is a result of the point being manufactured from a flake, and the bulbous rounded corner is what is left of the striking platform of that original flake blank. In sum, this variant may be due to a distinct
manufacturing process from other points in the assemblage where thin blanks were employed. At least 17 of the 25 have surface flaking forms that are parallel-oblique with the remaining have a random type of random flaking pattern.

Figure 6-7. Image of a mixed edge type from the Mackenzie I site assemblage (WHS-861).

Of the overall sample of 119 points, 68% (n=81) have concave bases, 62% (n=119) have parallel-oblique flaking, and 48% have both concave bases and parallel-oblique flaking patterns. Lateral basal grinding, similar the other samples was present on 33% of the points along the lateral edges with 93% of those points also having concave bases. Table 6-5. lists basic characteristics of each point in the sample for the Mackenzie I site. Lateral basal grinding, like the other samples was present on 33% of the point samples along the lateral edges with 93% of the points having concave bases.

Table 6-5. Morphological traits of the Mackenzie I site assemblage.

<table>
<thead>
<tr>
<th>Point</th>
<th>Lateral Sides</th>
<th>Flaking Pattern</th>
<th>Basal Edge</th>
<th>Lateral Basal Grinding</th>
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<td>Concave</td>
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</tr>
<tr>
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<td>Straight</td>
<td>P/O</td>
<td>Flat</td>
<td>Not Present</td>
</tr>
<tr>
<td>WHS-1256</td>
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<td>P/O</td>
<td>Concave</td>
<td>Present</td>
</tr>
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<td>Concave</td>
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<td>Present</td>
</tr>
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<td>Concave</td>
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</tr>
<tr>
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<td>P/O</td>
<td>Flat</td>
<td>Present</td>
</tr>
<tr>
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<td>Concave</td>
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</tr>
<tr>
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<td>Concave</td>
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</tr>
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<td>Concave</td>
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</tr>
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</tr>
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<td>WHS</td>
<td>Type</td>
<td>P/O</td>
<td>Shape</td>
<td>Status</td>
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<td>--------------</td>
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<td>Random</td>
<td>Flat</td>
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Note: P/O = Parallel-Oblique
6.5 Global Procrustes Analysis

To begin, like the methodology for the Mackenzie I points, the 3D scanned shapes for the comparative samples underwent an overall General Procrustes Analysis. The resulting shape data was captured and presented as principal component scores (PC). As noted earlier, these quantifiable PC scores can then be examined using a Principal Component Analysis (PCA) to transform several correlated variables into a smaller number of uncorrelated variables. The score for PC 1 has a Proportional Variance of 0.40786 meaning that PC1 represents 40.8% of the variability in the data. As mentioned earlier, the resulting PC scores are robust when generally the largest percentage of change is captured by the first two PC scores, then subsequently distributed throughout the remaining numbers. If the PC scores generated are more evenly distributed from the first score, then comparison of the variables isn’t considered to be robust. As an example of the PC scores generated by the GPA, Table 6-6 lists the first 10 scores and their proportion of variance captures, which equates to 84% of the overall total variation.

Table 6-6. Example of first 10 PC scores from the Global GPA.

<table>
<thead>
<tr>
<th>PC Scores</th>
<th>PC1</th>
<th>PC2</th>
<th>PC3</th>
<th>PC4</th>
<th>PC5</th>
<th>PC6</th>
<th>PC7</th>
<th>PC8</th>
<th>PC9</th>
<th>PC10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Deviation</td>
<td>0.09225</td>
<td>0.04488</td>
<td>0.03909</td>
<td>0.03725</td>
<td>0.03710</td>
<td>0.02792</td>
<td>0.02678</td>
<td>0.02475</td>
<td>0.02257</td>
<td>0.02202</td>
</tr>
<tr>
<td>Proportion of Variance</td>
<td>0.40786</td>
<td>0.09655</td>
<td>0.07324</td>
<td>0.06650</td>
<td>0.04819</td>
<td>0.03736</td>
<td>0.03438</td>
<td>0.02936</td>
<td>0.02442</td>
<td>0.02323</td>
</tr>
<tr>
<td>Cumulative Proportion</td>
<td>0.40786</td>
<td>0.50441</td>
<td>0.57765</td>
<td>0.64414</td>
<td>0.69234</td>
<td>0.72970</td>
<td>0.76408</td>
<td>0.79344</td>
<td>0.81786</td>
<td>0.84109</td>
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</table>

As the table illustrates, the distribution of proportional variance is evenly distributed within the assemblage. PC score 1 and PC score 2 comprise 50.3% of the total assemblage meaning that much of the proportional variance are comprised within these two scores. For this analysis, there were a total of 191 PC scores generated by the GPA. 180 of these scores captured approximately 100% of the total shape variance. Beyond the PC 10 score (and even before), shape variance is represented in such minute detail that it is too subtle for the naked eye.

As with the PC scores from the Mackenzie I intra-site analysis, each PC score is separated along an axis that has positive and negative vectors and illustrate the differences in overall shape variance. The PC1 negative scores represents a tapered
edged, rounded base that is relatively thick when compared to the other points (Figure 6-8). The positive representation of PC1 vector represents a thinner, straight/parallel-sided edge with a concave base (Figure 6-8).

![Figure 6-8. A representation of the positive and negative vectors (shape variance) for the PC1.](image)

In contrast, PC2 represents only 9.65% of overall total shape variance and is represented along the negative vector as a thick, rounded base with slightly tapered side edges, while the positive vector highlights a thin, parallel sided, concave base form (Figure 6-9).

![Figure 6-9. A representation of the positive and negative vectors (shape variance) for the PC2.](image)

Warped positive specimens along the PC1 axis represents the majority of the Mackenzie I and Minnesota projectile points (Figure 6-10). The more straight-sided basal edges and a concave base is seen in most of the specimens. Variation represented along the negative axis of PC1 and the positive specimen of PC2 is represented in the assemblage in the Mackenzie I specimens as well as the Manitoba and northwestern Ontario specimens. Variations between the positive and negative axis of both PC1 and PC2 are also represented in the four regions albeit in less frequency.
The first global GPA plot illustrates that there is considerable variation between the four groups but also some similarities and overlap. As an illustration, the majority of Mackenzie I points (73%) plot along the positive portion of the x-axis, alongside 58% of the Minnesota projectile points (Figure 6-11). With regards to shape variance most points from these two areas are represented by parallel edge points with concave bases.

Conversely, 77% of the projectile points from Manitoba and 75% of the projectile points from northwestern Ontario plot along the negative portion of the x-axis, meaning that overall shape variance is represented by a basal shape that has constricted edges (possibly stemmed) and a rounded base (Figure 6-10).

Results of the GPA illustrate that the closest similarities in overall morphometric shape variation is between the majority of the Mackenzie I and Minnesota points. At the same time, the GPA highlights a greater degree of similarity in shape between the northwestern Ontario and Manitoba points, although these two samples contrast with each other in different ways.
Overall, the results also illustrate that there is overall shape difference between point bases from both the Mackenzie I site and Minnesota when compared to the northwestern Ontario and Manitoba sites, with some overlap. Such results may indicate somewhat differing ages for the intensive use of components or be related to contemporary social distinctions/communities of practice variation as will be discussed more below.
Figure 6-11. Global PCA plot of PC1 vs PC2.
To explore any possible further differences and/or similarities between these groups produced by the global GPA, a between group comparison was completed. The between group GPA is a statistical test that compares the mean PC scores (the 181 PC scores) of each group (Figure 6-12).

![Figure 6-12. GPA plot of PC1 vs PC2 between group comparison.](image)

This method reduces the PC scores to three axes for comparison. In this case, the first axis captures 92% of the proportional shape variance, while axis two captures six percent and the third axis captured two percent of the overall variance (Table 6-7).

<table>
<thead>
<tr>
<th>Component</th>
<th>Eigenvalue</th>
<th>% Variance</th>
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<tbody>
<tr>
<td>1</td>
<td>0.00299628</td>
<td>92.655</td>
</tr>
<tr>
<td>2</td>
<td>0.000187178</td>
<td>5.7882</td>
</tr>
<tr>
<td>3</td>
<td>5.03476E-05</td>
<td>1.5569</td>
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</table>

Examining the between group graph (Figure 6-12), northwestern Ontario (80%) and Manitoba (60%) shape variance plots along the negative axis for component one, highlighting similar shape variance between those groups. This variance can be seen in the 3D representation in Figure 6-10 and consists of straight to slightly convex side edges, with rounded (convex) to flat basal apexes. The numbers for Mackenzie I and
Minnesota remain the same in those regions, indicating that despite a slight shift along component 2, shape variance between the two regions remains similar. These representations consist of straight side edges with concave bases.

PAST4 also allows for the examination of which PC scores are affecting each of the three components and displays it in bar graph form (Figure 6-13). Along the positive portion of Component one, PC scores one, three and four have the highest representation and thus the highest influence on the overall analysis.

![Figure 6-13. PC score influence for the between group Principal Component Analysis for Loading One.](image)

In sum, the results of this information suggest that the shape characteristics driving the spatial segregation of the Mackenzie I and Minnesota points apart from the points from Manitoba and northwestern Ontario, in both the GPA and between group GPA, is the variance in concave base shape. This characteristic also can be illustrated graphically when warping the images (Figure 6-14).
Alternatively, examination of the loadings for PC2 indicate that other shape variance is driving the GPA (Figure 6-15).

Most of the influence for the between group GPA are PC scores 2 and 5. Although other PC scores do have an influence, these two PC scores have the highest effect. These PC scores are represented by straight to slightly convex basal edges with flat or slightly
rounded bases. Most of the projectile points from Manitoba and northwestern Ontario fall close to these representations and thus are plotted as such in the between group GPA. Once again this can be seen graphically when warping the images as in Figure 6-16.

Figure 6-16. Illustrations of the positive axis for PC 2 and PC 5 shape variance.

6.6 CVA Analyses

To better understand shape variation and how that variance is represented between the regions, a Canonical Variates Analysis (CVA) was completed to compare the overall shapes of the points from the four regions (Figure 6-17). As noted in the previous chapter, a Canonical Variate analysis (CVA) is a widely used method for analyzing group structure in multivariate data. It is mathematically equivalent to a one-way multivariate analysis of variance and often goes by the name of canonical discriminant analysis. The axis measures the variance within the total assemblage with the X-axis having the largest degree of morphological variation and the Y-axis having less variation. Together the two axis total 85% percent of the total variation represented by the PCA scores. The resulting plot is a representation of the PCA scores that were generated.

Figure 6-17. Convex hulls highlighting results of the CVA from the resulting 3D GM shape data.
Using convex hulls to outline the maximum extend of each distribution, it becomes apparent that shape variance from the Mackenzie I site at lower right in purple overlap with Minnesota that plots more towards the upper right in blue, and that both the Minnesota and Mackenzie I site points plot along the positive portion of axis one. Alternatively, points from northwestern Ontario (upper left in orange) and Manitoba (lower left in red) plot along the negative portion of axis one (Figure 6-17). The separation of shape variance between the groups is more apparent when using the 95% ellipses. This type of plot assumes a bivariate normal distribution whereby each region is an estimate of where 95% of the population points are expected to plot (Figure 6-18).

Figure 6-18. A canonical variate analysis at 95% ellipses plot of the resulting 3D GM shape data.

There is also a greater similarity/closer relationship between points from northwestern Ontario and Manitoba, although they do not overlap. Using the 95% ellipses outliers can be seen beyond most ellipses. These outliers could represent similar but slightly different shape variation derived from interaction with groups in still other regions. A larger comparative sample would be needed to confirm causation. Regardless, the outliers are few and far between. As can be clearly seen, there is overlap between the Mackenzie I and Minnesota samples indicating they are not statistically different despite having only partially overlapping distributions whereas both the Mackenzie I and Minnesota samples are statistically different from the Northwestern Ontario and Manitoba samples in terms
of this plot. In turn the Northwestern Ontario and Manitoba samples, while more like
each other than to the more eastern samples, do not overlap at the 95% confidence level
and so are somewhat different from each other.

As another means to determine if this patterning is statistically valid, a multivariate
normality test was completed in PAST4 which computes the Mardia’s multivariate
skewness, with tests based on chi-squared (skewedness) (Table 6-8).

**Table 6-8. Results of normality test on the four regions discussed.**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Statistic</th>
<th>df</th>
<th>p (normal)</th>
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<tbody>
<tr>
<td>Skewness:</td>
<td>0.265</td>
<td>9.673</td>
<td>4</td>
<td>0.04631</td>
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</table>

The results for the p-values in the Mardia test are lower than the alpha 0.05, signifying
that there is evidence against the null hypothesis: the samples cannot be from a normal
distribution but are patterned at some level by region.

Given that the Mardia test indicated that the distribution data was not normal, a
MANOVA test was completed (Table 6-9). A MANOVA was chosen due to the test that
determines whether there are differences between independent groups with more than one
dependent variable. In this case, the dependent variables or groups were the geographical
regions and the independent variables consisted of the PC scores that were generated in
the PCA representing the shape variance determined through the GPA. The null
hypothesis this case is that the normal distribution of shape variance will be homologous
across the sites despite the spatial subdivisions.

**Table 6-9. Summary of the MANOVA tests completed on the four regions of projectile points.**

<table>
<thead>
<tr>
<th>Wilks; lambda:</th>
<th>0.7592</th>
<th>Pillai trace:</th>
<th>0.2436</th>
</tr>
</thead>
<tbody>
<tr>
<td>df1:</td>
<td>6</td>
<td>Df1:</td>
<td>6</td>
</tr>
<tr>
<td>df2:</td>
<td>428</td>
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<td>P:</td>
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<tr>
<td>P (same)</td>
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<td>P (same)</td>
<td>0.0000000002758</td>
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Results of the MANOVA tests illustrate that the p-values for the Wilks’ lambda and Pillai
trace are extremely low. Therefore, the null hypothesis, that there is a normal distribution
among the four areas, can be rejected.
Examination of the pairwise results of actual p-values for each region are displayed in Table 6-10. These numbers represent the actual p-values generated for each sample when compared to each other. What is interesting in this case is that several of the contrasts between the Mackenzie I, Minnesota and northwestern Ontario assemblages have a p<0.05 value indicating a significant difference between the samples from these areas. The Manitoba assemblage has a p-value >0.05 compared to the Minnesota and Northwestern Ontario assemblages suggesting that compared to those regions the sample is not significantly different but compared to Mackenzie I it is quite different.

**Table 6-10. Pair wise results from the MANOVA test between the four geographic regions.**

<table>
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<th></th>
<th>NW</th>
<th>MIN</th>
<th>MB</th>
<th>MK</th>
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</thead>
<tbody>
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<td>NW</td>
<td></td>
<td>0.03216</td>
<td>0.94067</td>
<td>0.00000000005458</td>
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<tr>
<td>MIN</td>
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<td>0.086802</td>
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<td>0.0000000035898</td>
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<td>0.00000000005458</td>
<td>0.086802</td>
<td>0.0000000035898</td>
<td></td>
</tr>
</tbody>
</table>

Note: Significant results at the .05 level are bold.

The results of the pair-wise comparison mimic the earlier plots and specifically suggest that there is not a significant difference in shape between the Mackenzie I site and Minnesota samples. Yet, there is a significant difference between the Mackenzie I site assemblage and those sites from northwestern Ontario and Manitoba. However, the Minnesota sample, while not different from the Manitoba sample, is different from the points from northwestern Ontario. The contrast with Ontario occurs despite the fact some of the points in the sample from the Quetico region were recovered in proximity. Finally, the samples from northwestern Ontario and Manitoba are not distinguished statistically. These results largely correspond to the CVA analysis results in terms of how the shape variation is similar or contrasts between Mackenzie I and the other samples.

### 6.7 Discussion

The regional comparisons were based on samples from limited and often geographically restricted regions. As noted above, samples were chosen based on accessibility and ease of which scanning could be completed in a timely manner. As a result, this exercise was also by no means an exhaustive one. Due to limited constraints with regards to budget
and access to all comparative data, it was an exploratory study and, to some extent, an exercise to develop a methodology that allows for comparison of overall shape data within a 3D environment. This environment has the possibility to offer analytical techniques that improve upon and supplement the older methods that have been employed in the region. A main objective utilizing this new technology was to create a technique that is less impressionistic when examining projectile point shape. At the very least, the 3DGM data base developed here should provide a foundation upon which future researchers can add more data and reassess the results.

At face value, that is ignoring the real possibility of sampling error, the results of the 3D GM regional comparisons above highlight several similarities or differences between the regional assemblages that are consistent with arguments made by previous investigators, or which logically follow from relative geographical position of those assemblages. The data indicate the projectile points recovered from the Mackenzie I site have the greatest similarities with regards to overall shape morphology, perhaps not surprisingly, to the more geographically adjacent available samples obtained in Minnesota. The main similarities or differences between the two can be seen when one breaks down and examines the frequency of various discrete outline attributes and surface flaking traits that characterize each of these samples (see Table 6-11). Both the Minnesota assemblage and Mackenzie assemblage have the highest percentage of concave basal forms (63% and 66% respectively) and have the highest percentage of parallel-oblique flaking patterns. However, in line with the fact Minnesota is somewhat different, the percentage of parallel-oblique for Minnesota (38%) is much less than that seen for Mackenzie I (67%). Also, in terms of lateral edge shape, straight, more parallel sides are less common in the Minnesota sample (29%) compared to Mackenzie (47%) and in these respects are closer to the other two samples. It should be noted that in the Mackenzie I assemblage other basal forms such as the “mixed” type with asymmetrical bases were observed, a form that was not present in any of the other samples.
Table 6-11. Morphological traits of all four locations discussed in this research.

<table>
<thead>
<tr>
<th></th>
<th>Lateral Edges</th>
<th>Basal Edge</th>
<th>Flaking Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tapered</td>
<td>Straight</td>
<td>Concave</td>
</tr>
<tr>
<td>Manitoba</td>
<td>15</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Minnesota</td>
<td>17</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>NWO</td>
<td>39</td>
<td>11</td>
<td>20</td>
</tr>
<tr>
<td>Mackenzie I</td>
<td>51</td>
<td>45</td>
<td>81</td>
</tr>
</tbody>
</table>

The 3D GM comparisons also show that the shape of the northwestern Ontario and Manitoba samples are most like each other and that they contrast with the Mackenzie I site sample although less so with the Minnesota sample in terms of the MANOVA results versus the CVA plots. They differ in more concrete terms from Mackenzie samples by having a low percentage of straight/more parallel lateral edges (38% for MB and 22% for NWO) as well as fewer concave bases and much reduced frequencies of the parallel/oblique flaking patterns.

These results are consistent with some earlier studies that have suggested that the more interior, non-Minong sites, which dominate the NWO sample employed herein, differ from Minong sites of which Mackenzie I is an example. For example, Pettipas (2013) saw that sites in the interior were more like developments in Manitoba than they were to the “Lakehead Complex” of the Lake Superior area. In addition, and as discussed in Chapter 2, Ross (1995) saw regional variation between several more northwesterly Ontario developments and the Lakehead Complex sites and his more northwesterly located Lake of the Woods/Rainey River Complex of his “Interlakes Composite” conception. Also, Julig (1994) also saw differences in point assemblages between Lakehead Complex and the interior sites in northwestern Ontario. However, those other studies do not necessarily suggest distinguishing the regional point samples in the same ways and can be contradictory in terms of specifics to the current results. Also, as noted earlier, some such as Markham (2013) see such contrasts as overdrawn.

To evaluate these potential regional contrasts more explicitly with the 3D GM data, the sample from northwestern Ontario was split up into two groups, including finds removed from the Minong beach/Lakehead Complex (Lakehead/Superior samples) and a category of Interior NW samples consisting of samples from Quetico, Lake of the Woods, etc.
Using these refined categories, new CVA convex Hull and 95% ellipse plots were generated (Figures 6-19, 6-20) along with a MANOVA and Pairwise tests (Tables 6-12 and Table 6-13). Not surprisingly, the CVA plots mimic the earlier analyses in that the Minnesota, and Mackenzie I plot closer together and overlap, despite a shift along the axis. At the same time, if anything the plots for the Interior NW and Manitoba samples indicate a closer relationship as the 95% ellipses now overlap. Thus, the result suggests the shape variation of the Lakehead/Superior area points was influencing to some degree those samples in the earlier CVA analysis (Figures 6-19 and 6-20).

Figure 6-19. Convex hull data highlighting results of the CVA from the resulting 3D GM shape data with refined NWO data.
Figure 6-20. 95% Ellipsis data highlighting results of the CVA from the resulting 3D GM shape data with refined NWO data.

Table 6-12. Result of MANOVA with refined NWO data.

<table>
<thead>
<tr>
<th>Wilks’ lambda:</th>
<th>Pillai trace:</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.876E-05</td>
<td>3.531</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>df1:</th>
<th>df2:</th>
<th>F</th>
<th>p (same):</th>
</tr>
</thead>
<tbody>
<tr>
<td>744</td>
<td>118.9</td>
<td>1.444</td>
<td>0.006554</td>
</tr>
</tbody>
</table>

In fact, the Lakehead/Superior area assemblages now plot very differently from the Interior NW and Manitoba samples in the more refined CVA (Figure 6-17, 6-18), although they are not statistically different using the alternative MANOVA pairwise comparisons (Table 6-13). At least the CVA plots suggest that there are potentially
differences in the available Ontario samples between the Superior/Lakehead sites and the Interior NW sites as argued by some previous researchers. However, the fact the Interior NW and Lakehead/Superior samples are not statistically different in the MANOVA suggests such contrasts may be overdrawn and approached with caution. In fact, as hinted above, some contrasts suggested by others are contradicted by the Mackenzie I sample. For example, and although he acknowledges sampling error may be playing a role, Julig (1994:191, 216) noted a high percentage of parallel-oblique flaking on interior (52.8%) versus Minong area sites (32.2%), a conclusion directly contradicted by the Mackenzie I Minong area sample (62%).

These new CVA plots also show the other Lakehead/Superior area samples available for this analysis are very different from the Mackenzie I sample and the Minnesota sample as well. Given their geographic proximity, notably for Mackenzie I and the other Minong area sites and finds, such results are seemingly measuring something other than simply contemporaneous spatial variation. These contrasts might be due simply to sampling error given the small size of the samples available for the other sites. More broadly, the clear contrasts between the same areas, such as between Mackenzie I and Lakehead/Superior sites, may reflect that those samples by themselves are inadequate, biased samples of even those small areas. The total absence of the common “mixed” base type in the Mackenzie I assemblage compared to other Lakehead area samples and even the other more removed comparative samples, certainly suggests sampling bias. In turn, the contrasts may indicate that there are time differences between Mackenzie I and the other Lakehead area assemblages.

It is possible, for example, that Mackenzie I dates later than most of the other samples available for the same region or even adjacent regions such as Minnesota. While the latter sample plots closer to the Mackenzie I sample in the CVA analytics (Figures 6-17, 6-18, 6-19, 6-20), showing that shape variation between the Mackenzie I site and the collections from Minnesota overlap, the MANOVA results suggest they are different. Indeed, the MANOVA shows that Mackenzie I is statistically different from all other samples (Table 6-13). It exhibits a range of variation not seen in the other samples. Ignoring the other Lakehead/Superior sample, it is plausible that the lack of statistical differences revealed by the MANOVA between the Manitoba, Interior NW, and
Minnesota is due to the fact they are all from multiple locations so could represent use over quite a period of time whereas the Mackenzie I site sample represents only a brief moment in time and as such is poorly represented in those comparative samples and appears quite different. These results also are at odds with Markham’s (2013) view that her inductively derived types of outline shapes from Mackenzie 1 are widespread and similar across the area. However, the restricted range of variation at Mackenzie I versus the other areas seen in the 3D GM analyses is consistent with her argument that that site assemblage is not as variable as it may appear at first glance if one relied heavily on more impressionistic typological comparisons to a range of types defined elsewhere (Markham 2013:171, 225-226).

6.8 Summary

To sum up, despite being somewhat variable overall, and the fact there are suggestions of differences between the various spatial clusters of points at the site, it is certain the Mackenzie I site assemblage by no means reflects the full range of variation of late Paleo “Plano” point styles documented in northern Ontario and adjacent areas. Indeed, the fact the larger Mackenzie I sample from a single site does not completely overlap with any other sample in the plots and statistically contrasts with almost all other samples near and far, clearly indicate it represents a range of variation not seen previously and serves to suggest how inadequate our current samples may be for reaching definitive conclusions about temporal or spatial variation.

The different range of variation at Mackenzie I versus all other samples might suggest that the site represents a more restricted segment of time within the overall Paleo occupation of northwestern Ontario and adjacent areas and not just spatial variation. For example, Julig (1994:216) noted that in the Minong area sites in his sample, many continuous variables were multi-modal and even the frequency of some attributes could vary widely between Minong area sites; his Cummins site sample had 62.5% concave bases (which is more like Mackenzie I; 68%) whereas his Brohm sample had fewer such bases (39.5%; Julig 1994: Table 6.3). Julig (1994) suggested this variation represented continuous use of the area over a considerable period. Also, the Manitoba sample used here had point forms typologically identified as potentially Agate Basin, Goshen, Cody
Complex or terminal Paleoindigenous Nipiwan (see Table 7), which would suggest occupations from perhaps as early as 10,000+ to 8000 RCYBP. Similarly, the northwestern Ontario sample has points that could also be seen as earlier Agate Basin forms as well as more terminal Paleoindigenous parallel-oblique flaked examples. Finally, the Minnesota samples has some items that could also be seen as earlier types such as Agate Basin and Dalton as well as parallel-oblique flaked forms that seem to date later, not seen at Mackenzie I. In all three cases, and unlike the Mackenzie sample location, those samples are also in areas that had some expanses free of glacial ice or higher lake levels that would allow for a much longer potential span of occupation. The question of the exact age of the Mackenzie I site, and its suggested restricted period of use is considered in the next chapter.
Chapter 7

Beyond Geometric Morphometrics: Age and Affiliations of the Mackenzie I Assemblage

In the previous chapter, examination, and comparison of the 3D GM shape variation between the points from Manitoba, Minnesota, northwestern Ontario, and the Mackenzie I site was completed. The regional analysis suggested that when compared as a whole, the Mackenzie I site assemblage differed from all points from northwestern Ontario and Manitoba. Similarities however were noted between shape variation from the Mackenzie I site assemblage and those points obtained from Minnesota although that sample includes a few items that typologically seem quite different. When refined analyses were applied by splitting up the original NWO sample, projectile points from the Superior Basin area contrasted with those from further west, in Lac Seul, Dog Lake and Lake of the Woods. It was illustrated that points from the Mackenzie I assemblage differed in 3D GM shape variation when compared to every other northwestern Ontario sample. The analysis sheds light on how inadequate samples have been for documenting the full range of point variation that exists within the region. The analysis also suggests that the contrasts that are seen in the Mackenzie I assemblage from other available samples plausibly could mean that the site itself was occupied for a brief period when compared to the overall Paleoindigenous occupation of the region.

The question of just how old is the Mackenzie I site and how it relates to sites and occupations farther afield beyond the primary area of study here is raised when considering the results of the analysis. Unfortunately, we lack 3D GM point samples from other areas, so the 3D GM comparisons here have limitations for understanding the overall sequence of Late Paleoindigenous occupations within northwestern Ontario and the external relationships to better dated developments farther afield. As a means of addressing these questions, a comparison between the Mackenzie I assemblage against previous non-3D GM studies can potentially aid in understanding that variation.
Stressed throughout this research is the fact that there is considerable variation within Paleoindigenous projectile point data as a whole from across northwestern Ontario (e.g., Fox 1975; Hinshelwood 2004:231; Ross 1995). As a result, a few researchers, such as Ross (1995:249-250) have cautioned against attempting to typologically categorize the range of variation in the western Great Lakes region.

However, other previous investigators (Dawson 1983; Fox 1975, 1980; Julig 1994; MacNeish 1952) recognized the wide range of styles recovered and attempted to make comparisons of these styles to other Late Paleoindigenous types/assemblages from further afield. As noted above, these comparisons included suggestions of assignments to western Plano styles such as Planview, Agate Basin, Hell Gap, Scottsbluff, Angostura, Frederick, Lusk, etc. described earlier that date from between ca. 10,500 to 8000 RCYBP in those western regions (Kornfeld et al. 2010:84-94). In the past, where points are compared or assigned to recognized types, many investigators have tended to often identify points from northwestern Ontario specifically as Plainview or Plainview-like (e.g., Dawson 1983; MacNeish 1952; Noble 1972:21) or reluctantly in some cases as Agate Basin (Julig 1994:216; Ross 1995:249), which to the west and southwest are the earliest dated Plano forms (see Chapter 2). Only rarely do researchers identify other western Late Paleo types (Fox 1975; 1980; Hinshelwood 2004; Julig 1994; Pettipas 2013:45; Ross 1977). Beyond the western types, a few individuals have seen similarities to types defined to the east, extending into the southern Great Lakes area and beyond. For example, Julig (1994) saw similarities between the concave-based forms at Brohm and other sites to Holcombe type points or cognate styles defined from sites in southern Michigan and adjacent Ontario (see Ellis and Deller 1990; Fitting 1969; Fitting et al 1966). Comparable forms occur even farther east into northern New England where they are called Cormier-Nicholas type points. Age estimates of Holcombe/Cormier-Nicholas points by geoarchaeological and other means indicate they date about 10,200 to 10,000 RCYBP (e.g., Ellis 1997:14; Lothrop et al. 2016:232). The Cormier site in Maine yielded a single radiocarbon date of ca. 10,200 RCYBP. Like the western Plainview and Agate Basin types, they date quite early. As the western Plainview and Agate Basin designations have been used most often in Ontario and adjacent areas, they along with the Holcombe comparisons are the focus of discussion here.
The designation of some items as Plainview was introduced by MacNeish (1952) when comparing the recoveries from the Brohm site. He did so based on an impressionistic and hence, limited comparison to the points (see Figure 2.1A) from the Plainview site located on the Texas plains where they were first reported (Sellards et al. 1947). In that early report, the Plainview projectile point is described as an unfluted, concave-based point with parallel to slightly constricted lateral edges towards the base and random to parallel-collateral surface flaking (Sellards et al. 1947:942). Notably, at the type site in only one possible case was “ripple”/oblique flaking of parallel scars on both faces of the point observed (Sellards et al. 1947:942).

Given the lack of other comparative evidence or information regarding Late Paleoindigenous occupations and material culture, MacNeish (1952) speculated that the points from the Brohm site were most like, and consistent with, those from the Plainview site and possibly a derivative thereof. In doing so, the parallel-oblique flaking common at Brohm became an identifier for researchers in northwestern Ontario synonymous with a Plainview-like designation. It is not surprising that MacNeish (1952) would make the comparison to finds so far afield as there were few other reported sites at the time, but it was that comparison that carried weight for further research within the region. The term Plainview-like caught on in northwestern Ontario and many researchers used it as a catchall term to describe the comparable concave-based lanceolate forms. In Minnesota and Wisconsin, while they tend to be reported less from more northern portions, perhaps due to less intensive modern land-use and hence site discovery, Planview and Agate Basin points, as well as some later types, were and are commonly recognized (e.g., Bozhardt 2003:21-24; Buhta et al. 2011; Carr and Bozhardt 2010; Ellis et al. 2011:543-544; Hill 1994; Winkler 2011:240). Beyond the southern Plains area where they were originally recognized, the term Plainview is seen by many as simply a catchall category for any shallowly concave based, not exceedingly thin, collaterally flaked, relatively parallel-sided, often basally thinned, point (see Bozhardt 2003:23; Knudson 2017). Given the restricted age and location of Plainview as described by Knudson (2017) these other types cannot be labelled as Plainview and therefore require a new typological designation.
Knudson (2017:75) did envision an earlier dating, broad horizon of similarly shaped unshouldered/unstemmed lanceolate, concave-based, biface forms across both the southern and northern Plains. Strong regional interactions would justify the notion that both ideas and goods would have been exchanged between groups, but that regional variations would have existed and should be categorized accordingly. In Knudson’s (2017:77) mind this limited the “Plainview” type to the south. Plainview per se, according to Knudson (2017:77), exhibits some modality, with undistinguished facial flaking of a lanceolate projectile point or cutting implement with a generally concave base, that was manufactured during a certain period of time in a certain region. Dates from Plainview sites range between 10,300 and 9800 RCYBP and, despite some contradictory dating evidence, largely pre-date 10,000 RCYBP (Holliday et al. 1999). Others have noted that Plainview points from the southern Plains are very similar to Goshen type points found on the northwest Plains and into the Rocky Mountains. In fact, Buchannan et al. (2000) show they are morphometrically pretty much the same. Goshen points, however, date even earlier with evidence indicating they even began to be made in pre-Folsom fluted point times, having an overall date range of ca. 11,000 to 10,200 RCYBP (Kornfeld et al. 2010:76-79). Whether the concave-based points from the upper midcontinent, including the western Great Lakes area, are identified as Plainview or not, many suggest they date to a similar, post-fluted point time as Plainview per se or ca. 10,000 RCYBP (Hill 1994:232).

Agate Basin type points (Figure 2.1B) are best known across the Plains where they date relatively early, from ca. 10,500-9800 RCYBP (Kornfeld et al. 2010:85-86), but the type is also reported to the immediate south of the northern Ontario Late Paleoindigenous finds (e.g., Bozhardt 2003:23; Hill 1994:232-234)-and to the east into even southern Ontario (e.g., Ellis and Deller 1986). These points are thick, elongated, relatively narrow, unstemmed, lanceolate forms that contract slightly towards a base that is generally either slightly convex or straight (see Chapter 2 discussions and Bradley 2010:481-485; Pitblado 2003:107-110). Most notably, these points exhibit a surface flaking that is largely horizontal rather than oblique and somewhat unpatterned or selective, and they have symmetrical outlines.
It is possible that some points from northwestern Ontario are Plainview or Agate Basin type points, and even some of the points from Mackenzie I have similar outline shapes. The problem is that both types (Plainview and Agate Basin) have a simple outline shape, that could easily be reinvented on more than one occasion (e.g., Julig 1994:27; Wilson and Burns 1999:228). The Mackenzie I sample also includes several items with asymmetrical outlines including those with “mixed” type bases, as well as other examples, and such are also not found on the other types. Also, the artifacts from sites like Mackenzie I and Brohm, as well as many more isolated Ontario finds (Fox 1975, 1980; Ross 1995:249), consistently exhibit the presence of parallel-oblique flaking on one or both sides of point. The Mackenzie I site assemblage has a very high percentage of tools and projectile points (62% of the points observed in this research alone) that exhibit such flaking (Figure 7-1). Indeed, one of the most unifying aspects of Paleoindigenous projectile points found in northwestern Ontario that often distinguishes them from types such as Plainview and Agate Basin are the consistent presence of parallel-oblique flaking on many items.

Figure 7-1. Example of parallel-oblique flaking on two types of points from the Mackenzie I site.
Such a flaking pattern dichotomy between Planview and Agate Basin type points and the northwestern Ontario examples is of potentially great significance. For example, O’Brien et al. (2014:115) argued that:

patterns of flake removal...are less sensitive to adaptive change driven by environmental conditions than is point shape because flaking is less strongly linked to performance than is point shape.

For that matter, such flaking will be less affected by resharpening or reworking than even outline shape. Despite initial descriptions by MacNeish (1952) who suggested that the Plainview points had parallel-oblique flaking, descriptions, or illustrations of that type of flaking are exceptionally rare to non-existent at the classic more western and southern sites. Similarly, the presence of parallel-oblique flaking is never mentioned in any Agate Basin type point description. Parallel flaking is only mentioned in discussions of other later types that have similar but still different outlines, as well as often asymmetrical shapes, such as Angostura (see below).

A similar critique can be used against assigning the concave-based forms to other more eastern developments such as Holcombe. The Holcombe and related forms reported from areas such as southern Ontario and Michigan and related points (Cormier-Nicholas) found east into northern New England are more straight-sided with thinned, concave bases and Holcombe points do not have parallel-oblique flaking (Pettipas 2013:45-46). Also, Holcombe points are noted for being extremely thin or often at or under 4-5 mm thick while none of the examples of concave-based points from sites such as Brohm are that thin (see Julig 1994: Figure 6.3).

As noted in Chapter 2, parallel-oblique flaking is commonly found on other point types widely reported outside Ontario including on forms with similar lanceolate outline shapes to the Plainview, Agate Basin and Holcombe types. Such flaking is reported on sites extending from western Minnesota (e.g., Jenks 1937) onto the northern Plains and adjacent western foothill and mountain areas. MacNeish (1952:28-30) himself noted that Brown’s Valley and points from the “Long” site, as well as other named Late/Terminal Paleo Plains points recognized at the time, exhibited parallel-oblique flaking. In his assessment of projectile points styles of the Brohm site, Pettipas (2013:45) also notes that
the flaking patterns suggest that the styles were best related to one of the Terminal Paleo point types/complexes and not Plainview.

In sum, across the Plains from western Minnesota to Wyoming (and beyond into the Rockies), there are several named Paleo point types recognized with parallel-oblique flaking that have similar gross, easily reinvented, outline shapes comparable to non-parallel-obliquely flaked, earlier dating, Plainview or Agate Basin or Holcombe forms. The straight lateral edges and concave or flat bases along with the presence of parallel-oblique flaking present at the Mackenzie I site are much more reminiscent of types recognized to the west mentioned in Chapter 2, including Frederick, Lusk, James Allen (e.g., Figure 2-1F), Brown’s Valley and/or Angostura (Boszhardt 2003:27-28; Kornfeld et al. 2010:92-94; Piblado 2003:112-117). Additional types with such flaking are found in the foothills and mountains of Wyoming and Montana such as Pryor Stemmed, Lovell Constricted and Ruby Valley (see Bradley 2010:494-495; Kornfeld et al. 2010:99-102). Most of these types have as whole have been referred to as the “Frontier Complex” (Bradley 2010:495; Frison 1978:34-38; Holder and Wike 1949; Frison 1978:34-38; Kornfield et al. 2010:495). The points exhibit evidence of percussion flaking as an initial form of manufacture for shaping and thinning, followed by serial, patterned pressure flaking that produces the parallel-oblique flake scar patterns (Bradley 2010:495). Bradley (2010:495) proposes that this technique originated in the Rocky Mountains and spread east across the upper plains of US, extending into the Dakotas and Minnesota. It is easy to extrapolate that this technique and reminiscent point forms could have also spread north into northwestern Ontario via population movements or continued external interactions. While the Ruby Valley points found in southwestern Montana may date as early as 9500 RCYBP, the remaining types as a whole date largely between 9000 to 8000 RCYBP (Kornfeld et al. 2010:92-102) and seem to represent the last gasp of Paleoindigenous style lanceolate point use even on the Plains. These forms are described in the next sections.

7.1 Parallel-Oblique point styles and affiliations

The Angostura point was first described by Hughes (1949:270) under the name “Long” (from “Ray Long” site) and was characterized as a large lanceolate form having: narrow
bases; straight to concave basal apexes; fine, sometimes oblique flaking; and ground lateral edges near the bases. Overall, they have an outline shape reminiscent of Agate Basin points (Figure 7-2).

![Figure 7-2. Examples of overall shape of several Plains and Foothill/Mountain variety Late Paleoindigenous projectile points, all of which excepting Agate Basin, feature parallel-oblique flaking.](image)

Wormington (1948) popularized the name in the third edition of *Ancient Man in North America*, but then altered the name to Angostura in the fifth edition (1957:139), which led to confusion surrounding the identification of Angostura points. Pitblado (2007:317) suggests that the term Angostura has been a “wastebasket” of typological class due the confusion, misrepresentation, and overuse of the term. Wheeler (1995:415) refined the initial description of the points adding that the “base is either shallowly concave or
irregularly straight”. Pitblado (2007:315) further refines the definition of the Angostura type as:

points [which] are lanceolate bifaces that have flaking patterns that range from most typically parallel-oblique to collateral to irregular and very rarely, horizontal, with some specimens showing different patterns on opposite faces. Basal sides of the point converge towards the base, which is usually slightly concave in outline.

In sum, they are reminiscent in outline shape of Agate Basin points (Figure 7-2).

These points can be symmetrical in transverse cross-section shape but can also be “D-shaped”, “twisted”, or otherwise asymmetrical (Pitblado 2007:316). In a re-examination of the Ray Long site specimens, Bradley (2015:11) adds that parallel-oblique flaking is oriented from upper left to lower right. The distribution of these points ranges across the Great Plains and the Upper Mississippi River Valley, found throughout Iowa, western Illinois, and western Wisconsin, but rarely in Minnesota (Morrow et al. 2016:155). Date ranges for Angostura sites range between 9700 to 7550 RCYBP (Pitblado 2003:116).

Frederick types were recovered from the stratified Hell-Gap site, Wyoming (Irwin-Williams 1973). As Kornfeld et al. (2010:92) note, the Frederick form at that site marks a change from the stemmed projectile points with transverse flaking of the Cody Complex to a longer, lanceolate form with parallel-oblique flaking (Table 2-1). Frison (1991:66) earlier noted this marked difference between Frederick and the earlier Cody Complex, suggesting that it is technologically younger and distinct, but he stressed Frederick points bear a close similarity to the Jimmy (James) Allen type, named earlier based on a collection from a Wyoming site of that name (Mulloy 1959). Such little difference prompted Pitblado (2007:319) to drop the term Frederick and eventually refer to such points as Jimmy Allen alone (see also Kornfeld et al. 2010:92-93). The Jimmy Allen style is lanceolate in form with well executed parallel-oblique flaking with parallel, slightly converging or slightly flaring (e.g., slightly concave, or “fishtailed”) basal sides (Pitblado 2007:318) (Figures 2-1, 7-2). Basal apexes are concave and can have a more pronounced basal cavity when compared to Angostura (Pitblado 2007:318). In other words, as with Frederick they are more “Plainview” like in outline shape (Figure 7-2).

Pitblado (2007:113, 319) notes that while Frederick/Jimmy Allen and Angostura points are often lumped together, but there are several attributes offer up several qualitative
differences between the two. For example, Jimmy Allen points tend to exhibit more parallel-oblique flaking (87% versus 52%), have moderate to deeply concave basal edges and have straight or more parallel to slightly contracting lateral edges towards the base (Pitblado 2007:320). Angostura styles on the other hand are more likely to exhibit non-parallel-oblique flaking (48% with versus 13% without), only slightly concave to almost straight bases and have lateral edges that converge, usually markedly, towards the basal end (Pitblado 2007:320). Quantitatively, Pitblado (2007:320-321) was able to statistically distinguish between Angostura and Jimmy Allen points along several dimensions. For example, while having similar maximum widths, the Jimmy Allen points have quite wide bases in comparison to Angostura points and of course, because the latter have narrower bases but similar overall widths, they contract much more towards the base. Visually, as stressed above, in terms of plan outline shape Angostura are more like Agate Basin points while Frederick/Jimmy Allen forms are more like Plainview and even Holcombe although they are most certainly not of examples of those types. In fact, Dawson (1983:9) called similar recoveries from the Cummins site Agate Basin-like and Plainview-like (although the former was specifically noted by him to be like Angostura points).

There are other named Plains types with parallel-oblique flaking such as Brown’s Valley and Lusk that have been recognized largely based on more impressionistic or metric discriminations from the Frederick/Jimmy Allen or Angostura forms and there are even some Foothill Mountain forms such as Alder-Ruby Creek (Figure 7-2). For example, Irwin (1968: 215-216) initially described Lusk points as lanceolate in form with constriction of the lower third portion of the point, invariably with concave basal edges. Finishing flaking is usually oblique, like that of Frederick but is rarely neat being generally haphazard on one or both faces. Grinding is present on the base with a lack of effort to make the points symmetric in outline (Irwin 1968:215-216). Lusk points have deeper concavities and tend to be narrow and thick versus the other types and Brown’s Valley type points are seen to be quite wide versus all other styles (Figure 7-2). However, many authors tend to lump those types in with Frederick/Jimmy Allen forms (e.g., Bozhardt 2003:27-28; Kornfeld et al. 2010:92-94; Pitblado 2003:113-116, 2007:316-319). Additionally, some of the foothill-mountain forms with comparable flaking, for example Lovell Constricted, are stemmed, and fishtailed like samples from the
Mackenzie I site (Figure 15 right side). These types have shallow concave bases with insloping, constricted basal sides and are somewhat stemmed (Figure 7-2). Other points across the Plains resemble Minocqua points recovered in Minnesota and at Cummins (e.g. Julig 1994: Figure 5.66b; Ross 1995:253; Salzer 1974). Salzer (1974:43) defines Minocqua points as having a slight inset, roughly parallel sided or contracting stem that terminates at the base in two short lateral projections or ‘ears’ (Figure 7-2).

In the absence of an exact comparative set of data base measurements for all the western forms, a direct comparative analysis is precluded. From a qualitative standpoint, however, using the point conceptions presented by Pitbaldo (2003), supplemented by data from others, there is strong evidence to suggest that there is a stronger resemblance between the Jimmy Allen and Angostura types and the Mackenzie I assemblage points (Figure 7-3) than to Agate Basin and the other earlier types. For example, both WHS-904 and WHS-30571 from Area D have shallow based concave basal edges, contract markedly towards the base, creating a narrow basal apex that is like Angostura or perhaps Lusk (see Figure 7-2). Alternatively, WHS-8944 and WHS-30666 from Areas A1 and A3, are parallel sided with relatively deep concave basal edges and wider basal widths are more like Jimmy Allen (Figure 7-3). Similarly, the high overall percentage of parallel-oblique flaking across the Mackenzie I site assemblage is also more consistent with those from Jimmy Allen assemblages than with Angostura types. Although many forms fit within these types, there are those that do not necessarily exactly conform such as WHS-3586 (Figure 7-3), which resembles Jimmy Allen with parallel sides and wide base, but deviates from the type by having a shallow concave basal edge. Several other examples from the Mackenzie I assemblage, including all the points recovered from Outlier Area 6 (highlighted in Figure 7-3) would not be out of place in Bozardt’s (2003:27-28) conception of the Upper Mississippi area “Frederick/Allen/Browns Valley” forms which are characterized by shallow basal concavities.
Figure 7-3. Examples of Mackenzie I projectile points and their typological resemblances (not identities) (scale = 1 cm).

The above discussion (and Figure 7-3) is not meant to imply that the Mackenzie I points are exactly examples of those other types. Rather, the intent is to suggest they are better
analogue for the Mackenzie I points and hence, can provide more reliable clues as to the age of the occupations and interaction networks.

### 7.2 Age of Mackenzie I Assemblage

While not identical to the western types, a relationship of them to the parallel-oblique sample for the Minong beach situated Mackenzie I site contradicts with how some other investigators, although not all (e.g., Pettipas 2013:45-56), have viewed Minong beach associated assemblages. For example, as discussed earlier, Julig (1994:190-192, 215-216) argued that typologically, Minong beach sites (sites found at elevations of glacial Lake Minong beach and strandlines such as Cummins, Brohm and Biloski) were a mixture of projectile points that are a result of loss and discard by numerous groups over a considerable period of time and were more similar to more southern and eastern types such as Holcombe.

Despite the variation within the Mackenzie I assemblage and the fact that many of the individual points possibly could be assigned to one or more existing types, the range of outline variation seen within the assemblage is consistent with the widespread parallel-oblique forms of several types found elsewhere including areas to the immediate south in Minnesota. Given these similar types of forms and appearance of parallel-oblique flaking, we might expect them to be of similar age. Moreover, if the western finds are any guide, earlier types, such as Angostura, have lower percentages of parallel-oblique flaking compared to later dating form such as Jimmy Allen. As Mackenzie I has a very large percentage of such flaking, this could suggest it dates somewhat later in the main period of use of such forms.

The presence of many of the sites in northwestern Ontario, specifically within the Superior Basin, have been tied to the time of development of the beaches and strandlines of glacial Lake Minong (see Chapter 2). Based on these associated strandlines, Fox (1980:137) believed that sites within the Lakehead region had a maximum age of 9500 RCYBP. Dawson (1983:23) believed that the Cummins site could date no earlier than 9500 RCYBP but felt that evidence suggested the site was used later for a lengthy period of time, between 9000 to 7000 RCYBP. Dawson’s (1983) temporal assessment of the occupation of the Cummins site extends beyond the formation of the Minong beach to
times when water levels had dropped below the site location. Hinshelwood (2004) addressed the idea of the re-occupation of Minong beaches and strand lines after lake water levels dropped. However, there is little evidence of such use of sites that aren’t situated in proximity to a raw material source. Despite evidence of later site use at the Cummins site, it is a bedrock outcrop location so it would make sense that later peoples seeking raw materials would have reoccupied and utilized the site.

Regardless, such elevated, well-drained, abandoned lake features could have provided excellent travel corridors, good views of lower terrain useful in subsistence procurement strategies and of course, as an added attraction, provide access to sources of raw materials for the manufacture of tools of the gunflint formation (Hinshelwood 2004). Other areas within the province exhibit sites that were re-occupied in a similar fashion. In southern Ontario, Deller (1979) noted that Paleoindigenous sites and findspots are known associated with lakeshores that pre-date the occupations by 2000-3000 years. As with sites in northern Ontario, these areas represent ecotonal situations whereby access to different resources both above and below the beach or strand lines could have been easily accessed and they may have been travel corridors for game such as caribou.

Although this argument suggests that it is possible that site location on a beach ridge does not necessarily reflect the time of occupation, Julig et al. (1990) did note the presence of artifacts reworked in such contexts by lake action at the Cummins site, an event tied by him to the earliest stage of Minong, and this suggested that some locations could possibly date as early as 9500 RCYBP. Nonetheless, there are definitive later Archaic occupations also at the Cummins site (Dawson 1983; Julig 1994; Julig et al. 1990), which shows that determining antiquity of occupation at the site is difficult from strandline location alone. Shultis (2013) work indicates that occupation of the Mackenzie I site occurred first around the time of the formation of the beach between ~10,500 to 9000 RCYBP and suggested it was most likely occupied between 9900 and 9000 RCYBP. when those beaches in her view were in existence. However, she admits that “were likely occupied around this time and/or more recently” (Shultis 2013:248). Considering dates from the Rosslyn pit (Zolti 1965) and the Cummins Pond (Julig et al. 1990) as well as the age of the Houghton lowstand (Yu et al. 2010), a more concrete age of occupation of the Mackenzie I site would fall between 9000 and 8000 RCYBP.
Regardless, sites such as Cummins, however one wants to interpret their specific age, seem to date only as early as ca. 9500 RCYBP at a maximum and are seemingly too recent even at that for occupations by groups who manufactured Plainview and/or Agate Basin style points. There is evidence however, suggesting Mackenzie I was occupied at the same time as groups from the west and southwest that manufactured parallel-oblique flaked styles, predominantly in the 9000-8000 RCYBP. It wouldn’t seem likely that the site would not have been occupied after 8000 RCYBP, since no other resources would have made the site attractive for occupation. Also suggestive of a later dating within the parallel-flaked point occupations is the presence of other artifacts like trihedral adzes in the Mackenzie I artifact assemblage. These distinctive tools are generally seen as most characteristic of, and common in, the immediately subsequent, post-Paleoindigenous, Early Archaic of the area beginning as early as 8000 RCYBP (see Cook 2015:6-8; Fox 1977; Pilon and Dalla Bona 2004). Yet, they also have been connected to Terminal Paleoindigenous occupations with lanceolate points as in the Caribou Lake Complex of Manitoba (Buchner 1984), which Pettipas (2013:54-58) argues has historical ties to the parallel-oblique flaked point tradition.

While no dates were obtained from the Mackenzie I site, an AMS date was obtained from charcoal at the Woodpecker 2 site, approximately 4 km to the west, a site that has yielded three parallel-oblique flaked points. That site is associated with shoreline related deposits at ca. 240 m and Shultis (2013:232) states:

> Artifacts recovered from within a nearshore depositional environment indicate that Woodpecker 2 was occupied during active beach formation.

Those same deposits yielded a date of 8680 +/- 50 RCYBP (Beta 323410; Norris 2012). Moreover, a cremation burial at the Cummins site, attributed to Paleo use, although not associated with any distinctive artifacts, was dated at 8480 ± 390 RCYBP (Dawson 1983:9). These dates are consistent with the typological comparisons and could further reinforce a relationship between the Superior Basin and parallel-oblique styles to the west and southwest, regardless of whether one wants to assign the Ontario finds to any specific type. Perhaps also consistent with the same overall age range is a point from Mackenzie I made from Hixton material from Wisconsin (see Appendix A, Mackenzie point sample WHS-13497). That item is somewhat unique at the site in having a slight stem, parallel-
collateral surface flaking, slight corner ears and a diamond-shaped cross-section (Markham 2012:154-155). Comparable points have been found in the vicinity of the Hixton source itself where they are referred to the Cody Complex (e.g., Hill 1994:234-235). As noted earlier, to the west the Cody Complex dates to the same post-9000 RCYBP era (ca. 8900-8500 RCYBP) and that it is contemporary with parallel-oblique flaked forms of the same age.

The Woodpecker 2 site, at 240 m, is at a lower elevation than Mackenzie I, which is located at 246-249 metres, so it is possible that the Mackenzie I site was occupied slightly earlier, or as a result of isostatic rebound, was occupied close to the same time. The north end of Mackenzie I site is higher and has an earlier Minong level formed strandline deposit. However, finds at Mackenzie I extend to lower elevations south of the strandline deposit and must post-date it. These finds, which in terms of points, seem much the same as those recovered from the northern portion (see earlier discussion and Markham 2013:223). In addition, as mentioned earlier, there are Paleoindigenous finds to the south of the Mackenzie I southern bedrock knob extending to even lower elevations with parallel-oblique points such as Newton, which may be part of the same site. For that matter there are other sites in the region with parallel-oblique flaked points such as the Simmonds site (DcJh-4) which is on “Post-Minong strandlines at 236 metres asl” (Markham 2013:57) so would have to date even later in time. Overall, it is very plausible therefore that Mackenzie I site dates to a similar age as the lower elevation sites, given that the Minong Lake levels fell quite rapidly.
Chapter 8

8 Retrospect and Prospect

The research has presented a detailed analysis from the basal portion of the projectile points recovered from the Mackenzie I site near Thunder Bay, Ontario with a primary focus on using a 3D geometric morphometric (3D GM) approach. Although the methodology employed in this research is unique for the area, the use of morphometrics is becoming increasingly popular to explore the nature and causes of variability within and between not only Paleoindigenous points samples, but artifact classes that share overall shape attributes.

Previous research, specifically within northwestern Ontario, had relied largely on more impressionistic assessments and to begin with, using comparisons with established Paleoindigenous point types/styles defined elsewhere. The use of such a typological approach was necessitated largely because of the small size and limited number of northwestern Ontario samples for analysis. Single component sites were few and the paucity of site samples overall especially in the 1950s when the Brohm site was first investigated. This research highlights some important factors with regards to typological identification. Research bias can play a large role in determining overall outcome of typologies. That is to say that because there are some characteristics of one type of style, on a projectile point such as a general outline shape, does not mean that projectile point has a similar origin, or even any type of immediate relationship, especially when considering other factors such as antiquity and geographic distance. In this case, the original association between points found in east of Thunder Bay were thought to have some relationship to similar looking ones in Texas, namely Plainview. Despite the lack of much supporting evidence, that designation held firm in the paradigm of the peopling of northwestern Ontario and buried itself in the minds of archaeologists working in the region for some time.

This, however, is not a problem unique to the area. Initial studies in many other areas have had to deal with a similar problem such as the Late Paleoindigenous occupations of eastern Canada where comparisons in the Far Northeast area emphasized similarities to,
more remote locations on the western Plains such as the Eden points of the Cody complex (see Wright 1995:105-106). With the discovery of more substantial local sites and point sample finds, the differences between such assemblages became more apparent and more local typologies were established (see Petersen et al. 2000, re: “St. Anne de Varney” points).

The Mackenzie I site represents the first site with a large enough sample upon which one can begin building a less impressionistic and better understanding of point variability. Such an artifact assemblage offers clues to site age and external relationships, and, as seen in eastern Canada, the more unique aspects of the points has led to calls for the development of more local typologies (Markham 2013). Unfortunately, the overall problem of limited number of small artifact samples persists, thus making regional comparisons problematic. Obviously, it is only with the discovery of several relatively substantial point assemblages from several sites that investigators in other regions have managed to develop more accurate regional characterizations of point variation and typologies, refined time sequences and potential external connections. As discussed, such was the case on the Plains and in the Far Northeast.

The Mackenzie I site represents an assemblage, largely recovered from bioturbated deposits. It appears from the resulting shape variation analysis herein to have been occupied for a relatively short duration of time compared to the overall Late Paleoindigenous record. Nonetheless, the site assemblage provides a starting point with a data base upon which future studies can begin to build less impressionistic typological approaches, utilizing both traditional measurements of variables and attributes in conjunction with more up-to-date 3D GM approaches.

The research presented here, utilized both a 3D GM analysis, comparing not only the Mackenzie I points to other regional samples, but also explored the use of the 3D GM approach to intra-site analysis. Using GIS analyses samples were compared from different spatial artifact clusters identified across the site. The intra-site analysis, which has never been attempted, might potentially aid in recognizing micro-temporal, functional and other differences of site use, which in turn can inform about the history of site occupation and activity organization. Examination of the micro-level intra-site data
suggests that the clusters identified through the GIS analysis, are statistically significant across the site with Area D and some other related “outlier” areas appearing to contrast with the other cluster areas. The differences are difficult to see with simple visual examinations. It is doubtful they would have been detected using simple continuous variables and ratios to measure shape contrasts and certainly would have been missed using traditional typological approaches.

There is another notable contrast between the areas and outliers across the site in that the areas with contrasting points detected by the 3D GM analyses match differing frequencies of the use of the exotic Hixton material. These contrasts occur above the shoreline deposits as well as below. If the 3D GM and Hixton frequency contrasts are indicative of temporal changes this could suggest that for most of the occupations the whole site was available for use. While this evidence of spatial point contrasts is suggestive and not necessarily conclusive of temporal changes during use of the site, the micro-level results are encouraging with regards to seeking out more subtle differences within the assemblage. It is worth exploring such methodologies at other larger Paleoindian sites and not just for refining chronologies or histories of site occupations. It would be appropriate to use at sites where others have suggested intra-site spatial “social/idiosyncratic” variation using more general measures of size, as well as manufacturing procedures/details of workmanship including flaking details such as the Lindenmeier Folsom site in Colorado (Wilmsen 1974) or the Parkhill Phase Thedford II site in southwestern Ontario (Deller and Ellis 1992). On a broader scope, one could apply the technique to potentially detect subtle temporal and other differences even within other broader categories such as named types. Reliance on such types alone tend to place temporal changes in discrete invariant “boxes of time” which, in addition to implying rapid changes from one category/box to another, imply the developments within such boxes were static and unchanging (see Feinman and Neitzel 2020).

The more macro-level inter-assemblage analysis was hampered by sample availability and size, which make conclusive determinations difficult. The Mackenzie I site contrasts with almost every other available sample with some (e.g., northwestern Ontario, Manitoba, and other Lake Superior/Lake Minong sites) more than others (e.g.,
Minnesota). Some of the contrasts, however, may be due to contemporaneous regional/spatial variation and of course, inadequate sampling.

Despite the sampling problems, the fact that Mackenzie I contrasts with almost every other sample which are aggregates from many sites and locations, even including other finds in the Thunder Bay vicinity, may be due to more to the fact that it represents a restricted segment of time versus the other samples. In turn, the contrast between the first large sample recovered from the area and other, even local sites and findspots serves to expose how inadequate overall sampling are for addressing even basic question about the age of these assemblages.

If one assumes that the Mackenzie I site represents a restricted segment of time, the question of exact age only can be answered by more traditional means, namely using geochronological methods such as strandline associations or comparisons to point assemblages from sites well-dated elsewhere. The use of geochronological data from the area is longstanding but the late glacial/early post glacial history of the area is incredibly complex and as indicated, the conclusions of various researchers can be somewhat imprecise. Many have seen these occupations as contemporary with and largely pre-dating 9000 RCYBP, because of such site locational associations. The tying of sites to features such as active strandlines are partly because researchers are desperate to date the sites, the allure of finding the oldest sites in the area (which admittedly also would help address extremely important anthropological problems) and, at some level, an underlying assumption that the dates derived from more natural science means are preferable to ones using archaeological means. However, as Hinshelwood (2004) and others such as Markham (2013:224-225) have stressed, many sites could have been occupied, not just at the time of the geological features as they developed, but after those features were formed. Those sites, however, would most likely only be limited to areas that intersect raw material sources as in the case with the Cummins site. It is more likely that the Mackenzie I site was abandoned after use, given the drastic drop in Minong Lake levels to the Houghton levels (Yu et al. 2010).

Few sites in the region have intact deposits suggesting that occupation when the beaches and strandlines were active or at the time close to it, the Woodpecker 2 and Cummins
sites being exceptions as discussed earlier. From an archaeological perspective, technological (e.g., surface flaking patterns) and, admittedly impressionistic, typological/attribute comparisons, suggest that there is a closer relationship between the points from Mackenzie I site and the well-recognized and better dates series of parallel-oblique flaked forms found to the west/southwest such as Angostura or Jimmy Allen. Across the western Plains and foothill mountains there appears to be a tradition of manufacturing resulting in parallel-oblique flaking of about the same age (Knudson 2017; Kornfield et al. 2010) during the Late Paleoindigenous period, and that tradition extends into northwestern Ontario and immediate adjacent areas. The technological tradition of using such points seems well dated primarily to the millennium after 9000 RCYBP to the west and as indicated, the one radiocarbon date available from the nearby Woodpecker site of ca. 8600 RCYBP and the fact that parallel-oblique flaked assemblages occur at elevations below the Mackenzie I site strandline would be consistent with that interpretation.

The assemblage of points from the Mackenzie I site does not need to be forced into the individual western types per se, but the dominance of parallel-oblique flaking that is so prevalent at the Mackenzie I site is more consistent with certain later dating western types such as Jimmy Allen or ones closer to the middle to end of the 9000-8000 RCYBP of this development. In turn, it is possible that the points from the Mackenzie I assemblage represents one of the earliest Paleoindigenous occupants in the general region as suggested by, for example, the early date from the cremation at the Cummins site. It is likely that the two sites could be somewhat contemporaneous given that Cummins lies between 233 and 245 m above sea level (asl). The Cummins site is situated near a bedrock outcrop and as such it is likely groups utilized this aspect of the site beyond its initial occupation (as evidenced by the middle period projectile points recovered). The higher elevation levels at the Mackenzie I site (246m to 249 m) suggest that it could have been utilized slightly earlier than the Cummins site during Minong beach formation but would have been abandoned after the water levels dropped. The absence of any source materials with which to make tools from and the recoveries of habitation tools such as scrapers and drills, and the basal portions of projectile points in such large numbers suggest there was an ulterior motive for use of the Mackenzie I site. It is more likely that
groups were following Caribou herds as they migrated either north or south and the Mackenzie River provided an excellent opportunity to hunt for subsistence. The high number of projectile point bases at the site suggest groups were returning to the site area to remove the broken bases, retooling the spears for future hunting purposes. The large numbers of other habitation tools suggest that the Mackenzie I site was an incredibly popular place, but as suggested by the geology of the area, utilized for a short period of time when considering the span of Paleoindigenous activity in northwestern Ontario.

To sum up, more morphometric data and analyses are required to refine our knowledge of the age external relationships of Mackenzie I and other northwestern Ontario sites and findspots. This will allow for a more credible understanding of the origins of people who moved into, and used over time, one of the last areas deglaciated areas in North America and who subsequently adapted to a very rapidly changing, dynamic environment. Further acquisition of 3D imagery of basal portions from Manitoba, Minnesota and even Wisconsin (due to the presence of Hixton in northwestern Ontario) would refine the results and enhance the picture as well as understanding the connections people between these areas as well as within northwestern Ontario. Incorporating data into comparisons from sites farther afield with typologically similar points such as Angostura/Jimmy Allen also would allow a more rigorous assessment of possible connections.

The methodology utilized in this research is beneficial given you do not need complete specimens to complete an analysis. Shape variation from basal portions can be included into the existing database to complete the comparison. Basal sections have this advantage for increased sample sizes and are less likely to be reworked and therefore introduce less “noise” into comparisons. As indicated in the point descriptions herein, some basal reworking does occur and some stress that reworking can certainly influence fore-section form differentially or more so than basal form (e.g., Shott et al. 2020; Shott and Otarola-Castillo 2021; Thulman 2019). Nonetheless, some researchers have shown even complete and reworked points may be useful in comparing assemblages with certain point types or that the form of point resharpening/reworking itself may be distinctive of certain types such as Clovis (e.g., Buchannan and Collard 2010:357; Smith et al. 2021). Hence, it would be useful in the future to use the complete point data scanned for this thesis in a 3D GM analysis to see how those results compare with the results seen here for the
interregional analyses where a larger sample size of complete points is available. One might even contemplate comparing the results using fore sections to bases as well to see how they affect the resemblances or lack thereof between samples seen in this study.

Regardless, with the advances in 3D technology and the popularity of 3D scanning on the rise, it will be a matter of time before this information can be shared digitally between regions without having to travel. A larger database can be compiled to begin to trace and track similarities between regions and within. However, as stressed in earlier chapters, and as should be clear from discussions above, ideally such morphometric data should be combined with technological/manufacturing and typological data as well as attribute frequencies and comprehensive sets of measurements; both approaches are useful and needed to gain a full understanding (Ellis 2019:214-215). Such data are also in short supply. As such, we also need detailed metrics, attribute and technical data of the kind employed/provided by Julig (1994:191-194) and Markham (2013) to allow for larger, more comprehensive, and concise comparisons from both Ontario and the multiple assemblages in adjacent and more remote geographic areas across the Plains and mid-continent.
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MacLeod, Norman  

MacNeish, Richard S.  

Magner, Michael  
Mandryk, Carol A. Stein

Marcus, Leslie F.

Markham, Samantha


McCulloch, Breana

Mason, Ronald T.

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McMillan, Kyle, James T. Teller

Meltzer, David J.

Metin, I. Eren, Stephen J. Lycett

Meyer, David
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Middleton, Keating H.

Million, Tara

Mills, Tammi

Mitteroecker, Phillipp, Phillipp Gunz

Morrow, Toby A.

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Powell, Louis H.

Read, Dwight W, Pete E. Lestrel

Renfrew, Colin

Reyment, Richard A.

Richie, William A.

Ringnéer Markus

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Robinson, Brian S., Jennifer C. Ort, William A. Eldridge, Adrian L. Burke and Bertrand G. Pelletier
2009  

Rockman, Marcy
2003  

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1993  

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1984  

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1977  
1995  
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2015  
Multi-analytical residue analysis of the trihedral adze: a case study for the introduction of new methodologies in boreal forest archaeology. Unpublished Master’s Thesis Department of Anthropology, Lakehead University.

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1966  

Salzer, R.J.
1974  

Saragusti, Idit, Avshalom Karasik, Ilan Sharon, Uzy Smilansky
2005  

Sassman, Keneth E.
2015  
Sebastian K. T. S. Wärmländer, Heather Garvin, Pierre Guyomarc’h, Anja Petaros, Andsabrina B. Sholts
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Weber GW, Bookstein FL.

Wendt, Carl

Weissner, Polly

Whallon, Robert Jr.
Wheeler, R.P.

Wilmsen, Edwin N.

Wobst, H. Martin.

Wood, Raymond

Wormington, H.M.

Wright, James V.

Yellowhorn, Elden

Zolti, S. C.
Appendix A

Photographs of Projectile points
Projectile points from Manitoba used for comparison.
Projectile points from Manitoba used for comparison.
Projectile points from Minnesota used for comparison.
Projectile points from Minnesota used for comparison.
Projectile points from Lake of the Woods/Kenora used for comparison (scale = 1 cm).
Projectile points from Rainy River region used for comparison (scale = 1 cm).
Projectile points from Quetico, Lac Seul and Dog River used for comparison (scale = 1 cm).
Projectile points from Interior NW Ontario used for comparison (scale = 1 cm).
Projectile points from Interior NW Ontario used for comparison (scale = 1 cm).
Projectile points from the Mackenzie I site used for comparison (scale = 1 cm).
Projectile points from the Mackenzie I site used for comparison (scale = 1 cm).
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Projectile points from the Mackenzie I site used for comparison (scale = 1 cm).
CV D.S. Norris

Curriculum Vitae

David S. Norris

CITIZENSHIP AND QUALIFICATIONS

Canadian Citizenship
Class G Drivers License (Ontario)
Ontario Professional Archaeological License P307
Ground Disturbance Certificate
Snowmobile Safety Certificate
Competent with ArcGIS 10.2 and QGIS applications
ATV Safety Certificate
Current web editor of the Canadian Archaeological Association website
2014 and 2015 Reviewer for the Totem – University of Western Anthropology Student Journal
Nautical Archaeological Society Level 1

LANGUAGES

English – Fluent (oral, reading and written)
French - Reading

EDUCATION

2013-present  PhD Candidate - Archaeology
Department of Anthropology, University of Western Ontario
London, Ontario
Supervisor: Dr. Chris Ellis
Thesis: Paleoindian Activity in Northern Ontario
2004-2007  
**Master of Arts – Archaeology**  
Department of Archaeology, University of Saskatchewan, Saskatoon, Saskatchewan  
Supervisor: Dr. David Meyer  
Thesis: *The presence of net-impressed and horizontally corded ware in southern Manitoba: the relationship between Rock Lake and Brainerd ware*

2003  
Wilfred Laurier University  

1994-1998  
**Honours Bachelor of Arts – Anthropology**  
Department of Anthropology, Lakehead University, Thunder Bay, Ontario  
Supervisor: Dr. Scott Hamilton  
Thesis: *Faunal Remains: Associating a Standard for Cut Marks Created by Stone and Metal*

### SCOLARSHIPS AND AWARDS

- [Peer-Reviewed]

### PUBLICATIONS

Hamilton, Scott, Jill Taylor-Hollings, and David Norris

[Non-Refereed]

Norris, Dave

2012 *Current Archaeological Investigations in Ontario: The discovery and preliminary information regarding several Paleoindian sites east of Thunder Bay.* The Minnesota Archaeologist (71):45-60.

Norris, Dave


Norris, David and Scott Hamilton


Hamilton, Scott, James Graham, Dave Norris

2004 *If These Walls Could Speak: Using GIS to Explore the Fort at Grand Portage National Monument.* Grand Portage Historical Monument, Minnesota


### PAPERS PRESENTED


Gilliland, Krista (Western Heritage, St Albert), W. Paul Adderley (University of Stirling), Terrance Gibson (Western Heritage, St Albert), Dave Norris (Western Heritage, Winnipeg) (2012) *Context, Chronology, and Culture: Problem-based Geoarchaeology at the Lakehead Complex Sites, Thunder Bay.* Paper presented at the 45th Annual Canadian Archaeological Conference, Montreal, Quebec.


**TEACHING EXPERIENCE**

June 2015  
**Basic Archaeological Fieldwork Training Course**  
- Created a basic training course for members of the Rocky Bay First Nation band  
- Created of lectures (5 days) covering the basic principles of archaeological method and theory  
- Created 5 days of field work, testing, use of GPS, artifact recovery and documentation

January to April 2015  
**Lakehead University**  
Contract Lecturer – Anthropology Department – WA 2118 – Tracing Human Migrations  
- Responsibilities included developing curriculum and topics relating to the migrations of the species Homo throughout the world  
- The development of lectures, handouts, and exams pertaining to topic

September 2013 to April 2014  
**University of Western Ontario**
Teaching Assistant for Anthropology 1020 Linguistics and Socio-Cultural Anthropology

- Attended lectures, assisted in group work, marked assignments, held office hours to help students in need

January to April
2006

University of Saskatchewan

Graduate Teaching Fellowship

- Responsibilities include the preparation of all material relevant to Archaeology 112.3: Introduction to Physical Anthropology and Archaeology including syllabus, hand-outs, and power point presentations
- Presentation of three 50-minute lectures per week (Monday, Wednesday and Friday).
- Preparation, invigilation and grading of all midterm and final examinations
- One on one instruction pertaining to identification, classification and designation of archaeological materials

January to April
2005

University of Saskatchewan

Teaching Assistant for ARCH 250 Lab

- One on one instruction pertaining to identification, classification and designation of archaeological materials - Plains cultures

WORK EXPERIENCE

2013 – Present

Woodland Heritage Northwest

Principal Owner/Senior Archaeologist

- Client development
- Client contact/managing budgets for developments
• Stage 1 and Stage 2 Archaeological assessments in Ontario
• Compliant reporting on Stage 1 and Stage 2 archaeological assessments in Ontario
• GIS Mapping, survey, field work
• Documentation of Archaeological resources within proposed developments

2012-2013  
**Northern Lights Heritage Services Inc.**
Project Archaeologist
• Managed crews in Manitoba for HRIA investigations
• Established clientele for company
• Completed stage 1 to 3 assessments in Ontario
• Complied with regulations, including reporting for provincial jurisdictions

2007-2012  
**Western Heritage**
Project Archaeologist
• Managed multimillion dollar projects
• Managed crews of 50+ employees for summer excavation
• Completed stage 1 to 4 assessments in Ontario
• Completed over 150 heritage assessments in Alberta, Saskatchewan and Manitoba
• Compiled project proposals an bids
• Established clientele managed working relations for company

May to August

2006  
**Western Heritage**
Field Technician
• Compilation, editing and compilation of regional information as well as field data to be included in Heritage Resource Impact Assessments (HRIA) interim and final reports
• GPS field orientation and navigation
• Systematic testing and reconnaissance of the Boreal Forest developments
• Systematic testing and reconnaissance of various developments including natural pipelines, oil flow lines and access roads, oil and gas well leases

May to October
2005  Western Heritage
Field Technician
Identification and cataloguing of artifacts recovered during various archaeological surveys.
• Preparation of information relating to developments submitted for heritage resource screening
• Drafting of figures and maps of archaeological sites and plotting them on NTS maps sheets for final reports, as well as report writing

July 2004  Ontario Parks and Natural Resources
Field Technician
• Field supervisor for survey, heritage assessment and excavation of historic and precontact sites
• Systematic testing and reconnaissance of high potential heritage resources
• Recorded site EjKI-4
• Purchased and organized field equipment and camp supplies

April 2004  City of Thunder Bay
Field Technician
• Completed stage 2 assessment of Hwy #11/17
• Systematic shovel testing
• Identification of artifacts in field and in lab

January to May 2004

**City of Hamilton**
GIS Technician

• Digitization of 18th century city maps for legacy project
• Worked with ESRI Archview 9.0
• Complied data for geo-referencing 18th century prospecting maps

September 2003 to May 2004

**Lakehead University**
GIS Lab Technician

• Completed several GIS based project relating to SCAPE project
• Mapping of archaeological sites in southwestern Manitoba
• Maintained lab computers hardware and software

September 1999

**Lakehead University**
Field Technician

• Stage 2 assessment of Rowdy Lake EdKo-6
• Systematic shovel testing and test unit excavation
• Artifact identification
• Lab analysis of artifacts including cataloguing

**RESEARCH EXPERIENCE**

May to August 2003

**Lakehead University - SCAPE Project**
Field Supervisor
• Supervisor of small work crew (5 persons) during systematic testing and excavation of site (Craig Bessant site, Hokanson Site (DiLv-29), Shuddemat, Gosslin (DiLv-30) sites in Manitoba)
• Implemented placement of survey grid, shovel tests and excavation units as well as suggested various sampling methods
• Trained students in archaeological field techniques
• Worked with surveying tools such as transits, total stations, and stadia rods

October 2002 to March 2003
Lakehead University – SCAPE Project
Lab/Field Supervisor
• Preparation, identification and catalogued artifacts recovered from a variety of archaeological sites relating to the SCAPE project
• Trained students in lab procedures and artifact identification
• Delegated tasks and completed several faunal analyses, smash indices, artifact distribution for final reports on materials relating to the SCAPE Project
• Edited final reports

September 2001
October 2002
Brandon University – SCAPE Project
Lab/Field Supervisor
• Preparation, identification and catalogued artifacts recovered from a variety of archaeological sites relating to the SCAPE project
• Trained students in lab procedures and artifact identification
• Delegated tasks and completed several faunal analyses, smash indices, artifact distribution for final reports on materials relating to the SCAPE Project

May to August
1998
SCAPE Project
Excavator/Surveyor (Manitoba)
• Worked with surveying tools such as transits, total stations, and stadia rods
• Organized displays and exhibits for open house events for the public
• Excavated sites

May to August
1997  SCAPE Project
Excavator/Surveyor (Manitoba)
• Excavated Precontact and Historic (Metis) sites during the Brandon University and Lakehead University joint field project
• Excavated sites DiMe-23, DiMe-24, DiMe-25

CURRENT PROFESSIONAL MEMBERSHIPS

• Canadian Archaeological Association
• Ontario Association of Professional Archaeologists (APA)
• Manitoba Association of Professional Archaeologists
• OAS – Ontario Archaeological Society – Thunder Bay Chapter
• Save the Ontario Shipwreck Society