VISUALIZING PALEOINDIAN AND ARCHAIC MOBILITY
IN THE OHIO REGION OF EASTERN NORTH AMERICA

A dissertation submitted
to Kent State University in partial
fulfillment of the requirements for the
degree of Doctor of Philosophy

by
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Chapter 1: Introduction

Mobility is frequently analyzed in eastern North American archaeology, as it can give researchers clearer insight into the particular social networks, behaviors, and choices that groups present throughout prehistory (Brown 1985; Kelly and Todd 1988; Anderson and Hanson 1988; Gramly 1988; Stafford 1991; Seeman 1994; Cantin 2000; Mullett 2009; Ellis 2011; White 2012). There are multiple cultural and environmental factors that affect group choices in relation to mobility including resource distribution, human population size, technological capabilities, and climate. Eastern North America has been inhabited by human populations for over 12,000 years, and it is generally accepted that “Early Paleoindians” - the earliest group to exploit the region - had the highest degree of mobility when compared to subsequent populations. Many researchers suggest that the degree of mobility decreased significantly between the Paleoindian period and the succeeding Archaic period. That concept, originally posited by Joseph Caldwell (1958) with his Primary Forest Efficiency Model, is the problem that will be addressed throughout this dissertation. Much of the archaeological research addressing temporal mobility change focuses on a discussion of change throughout phases at individual sites that were repeatedly used throughout time. These approaches do not address the size and scope of mobility in the way that regional scale analysis can, but they can say something about the group’s interaction with the surrounding environmental resources.

Resources are “materials available ‘in nature’ that are capable of being transformed into things of utility to man” (Harvey 1980, 220). “The fact that something … is regarded as a
resource (or not) tells us rather more about a society than it does about the substance itself” (Bridge 2009, 1220). This socio-environmental interdependency is what sets the framework for interpretation for this dissertation. Through mapping out the distributions of commodified lithic resources, and through evaluating the interaction of those lithic resources in space and throughout time, we can visualize the potential for changes and differences in mobility behaviors. Mobility is important because, prehistorically, cultural complexity is negatively correlated with the size of a group’s mobility range (Brown and Vierra 1983). This dissertation will discuss the implications for changes in cultural complexity throughout much of eastern North America’s prehistory based on the systematic analysis of these mobility patterns.

Archeologic and geographic methods and concepts are integrated to construct a framework in which both the temporal and geographic scale components of prehistoric mobility are considered. Mobility in the geographic sense refers to any type of movement of a group or individual, from one situation to another. Typically, in archaeological research, mobility is more literal and discusses group movement between specific geographic locations. Since prehistoric movement is difficult to decipher at a fine temporal scale, the time component of mobility within archaeological research is broader. So, rather than discuss a single group’s episodic migration patterns over an annual period, archaeologists typically only have the capacity to assess and discuss the resulting patterns of several iterations of that group’s multiple diffusion episodes as a whole, which can stretch over hundreds or even thousands of years. To navigate this constraint, archaeologists can generally discuss diachronic differences in mobility by distinguishing distinct styles of material remains that correlate to specific phases in time, and discuss differences in the patterns of those material remains over space.
1.1 Study Area and Timeframe

This research addresses both the temporal and regional conversation on mobility by focusing on mapping the distribution of the projectile points (stone tool hunting implements) of five successive culture groups in eastern North America. These groups exploited the region throughout the Paleoindian and Archaic periods from 12,000 B.P. to 4,000 B.P. The series chosen for investigation are: 1) Clovis/Gainey, 2) Thebes, 3) MacCorkle, 4) LeCroy, and 5) Brewerton Corner Notched (see Table 1.1). Each of these group ‘names’ refers to the name of the diagnostic projectile point that is specific to artifact assemblages within their timeframe. These projectile points are constructed of lithic raw materials that are tied to specific lithic outcrop locations on the landscape. I will seek to illustrate the longitudinal transitions in mobility on the landscape by mapping the distributions of these projectile points in relation to their source lithic outcrop. This project is premised on the assumption that the size and shape of lithic supply zones correlate to the size and shape of home ranges or territories of past human groups (Kelly and Todd 1988; Gramly 1988; Anderson and Hanson 1988; Seeman 1994; Stafford 1994, Cantin 2000; Daniel 2001; Holen 2001; Mullett 2009; Aagesen 2010; Ellis 2011; White 2012). The larger the lithic supply zone for a given raw material, the larger the territory; and correspondingly, the greater the mobility within that territory. The geographic scale of this research will stretch across hundreds of kilometers in Eastern North America. The study area for this particular project includes what is referred to today as the states of Ohio, New York, Pennsylvania, Kentucky, Indiana, Michigan, and West Virginia (Figure 1.1 Study area. with a focus centering on Ohio.)
Figure 1.1 Study area.
**Table 1.1 Reference Table for Select Projectile Points.**

<table>
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<tr>
<th>Point Type</th>
<th>Period</th>
<th>Dates</th>
<th>Main Characteristics</th>
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<td>Clovis/Gainey</td>
<td>Paleoindian</td>
<td>11,500-10,800 BP</td>
<td></td>
</tr>
<tr>
<td>Thebes</td>
<td>Archaic</td>
<td>10,000 - 9,000 BP</td>
<td></td>
</tr>
<tr>
<td>MacCorkle</td>
<td>Archaic</td>
<td>9,000-8,500 BP</td>
<td></td>
</tr>
<tr>
<td>LeCroy</td>
<td>Archaic</td>
<td>8,500-7,800 BP</td>
<td></td>
</tr>
<tr>
<td>Brewerton Corner Notched</td>
<td>Archaic</td>
<td>5,000-3,000 BP</td>
<td></td>
</tr>
</tbody>
</table>
1.1.1 **Paleoindian Period**

This investigation is concerned with roughly the first eight thousand years of human occupation in eastern North America, which spans the Paleoindian (12,000-10,000 BP) and Archaic periods (10,000-3,000BP). The Paleoindian period is often characterized as one populated by small groups of highly mobile hunter-gatherers exploiting a rapidly changing environment during the Pleistocene-Holocene transition. The extreme mobility of these groups is reflected in their toolkit, which contains primarily animal processing artifacts including large, bifacial projectile points (with long use-lives), hide scrapers, blades, and gravers. This timeframe is generally split into an Early Paleoindian period, lasting in Ohio from 11,500BP - 10,800BP, a Middle Paleoindian period from 10,800 to 10,300BP and a Late Paleoindian period lasting from 10,300BP - 10,000BP (White 2012, 173). A more detailed discussion of the Early Paleoindian Clovis/Gainey projectile points follows in the methodology section of this dissertation.

1.1.2 **Archaic Period**

The Archaic period follows the Paleoindian period, and encompasses over 7,000 years. The accepted range for the Archaic period is from 10,000 to 3,000 B.P. (Elliot and Sassaman 1995). It was originally defined by William Ritchie in the 1930s and is often characterized as a highly “transitional” period (p. 97). More realistically, the Archaic exists at a time of less dramatic environmental change than the Paleoindian period and the stabilization of both river regimens and the resources of the deciduous forests required considerable cultural flexibility. Sites of this period are notably frequent in the research arena. While it is presumed that Archaic groups maintained smaller mobility ranges than their predecessors, it is clear that a majority of Archaic groups were not static on the landscape. They were indeed mobile to some extent and followed a hunting, fishing, and collecting lifestyle. The 7,000 years of the Archaic period is
typically divided into three divisions. The first is the Early Archaic period from 10,000BP to 8,000BP. Well-excavated sites of this period include Koster (Brown and Vierra 1983), Rucker’s Bottom (Anderson and Hanson 1988), St. Albans in West Virginia (Broyles 1966), and James Farsley in Indiana (Stafford and Cantin 2009). Archaeological remains at these and other sites support the notion that Early Archaic groups were small and relatively highly mobile. The next temporal phase is the middle Archaic period from 8,000BP - 5,000BP. The Koster of Illinois, St. Albans, and James Farsley sites all have temporal components that extend into the Middle Archaic. Artifacts from the middle period sites indicate a longer term usage of the area. Regional similarities in assemblages suggests increased social connectivity. Finally, the late Archaic period from 5,000BP - 3,000BP is characterized by large, densely distributed sites located throughout the landscape. This explosion of sites on the landscape implies a potential increase in both population size and increased sedentism as demonstrated by the increased frequency of large, multi-seasonal base camps and the accumulation of dense organic middens, or concentrations of domestic waste products, throughout most of the Midwest.

1.2 Physical Environment

A general understanding of environmental characteristics in the region is necessary when considering the cultural changes within the study’s timeframe. Environmental factors relevant to the study area can be divided into two categories. The first discusses transitional environmental factors that change over time. These include descriptions of the different geomorphic features and climate-dependent characteristics including waterways, vegetal resources, and faunal communities of the Early Paleoindian and Archaic periods. The second category refers to slower changing environmental characteristics that are found on the landscape and do not dramatically change throughout the noted time periods, mainly including lithic raw material outcrop
characteristics and large scale topography. Both merit further clarification as they related directly to the mobility behaviors of prehistoric groups.

The Paleoindian period commenced with an environment heavily impacted by the end of the Wisconsinan Glacial Episode c.a. 12,000 years ago. The Wisconsinan Glacial Episode contained several glacial advances that reached the boundaries of the study area for this research (Fullerton 1986). The last glacial maximum was around 19,600 B.P., with Ohio being ice free by around 14,000 years ago (Lowell 1995). The main Erie Lobe of the ice sheet would have been straddling the border of the Lake Erie Basin and split Ohio into the glaciated terrain in the north and unglaciated and ice free terrain in the south (Dreimanis and Goldthwait, 1973). The post-glacial landscape of the study area is one in flux, which changed rapidly immediately following glaciation and slowed down to present day. There were adjustments in lacustrine and drainage systems throughout the Paleoindian period and extending into the Archaic Period. Mothersill and Schurer (2003) note that marshy conditions were likely present in depressions in the glaciated terrain throughout the region surrounding the Lake Erie basin. The western basin of Lake Erie would have remained free of water during the Paleoindian period to around 9,500 years B.P. (Mothersill and Schurer, 2003). The impact of repeated glacial processes on the landscape is evident in a landscape spotted with moraines, drumlins, kames, eskers, kettle lakes and peat bogs.

The termination of the ice age and the resulting climatic adjustments in the region significantly impacted the distribution and availability of both floral and faunal resources available for human use. In the immediate post-glacial period, the climate was cooler than that of today and seasonality was less pronounced with notably cooler summers. The vegetal environment at this time can be described initially as tundra-like interspersed by patches of
boreal forests. These immediate post-glaciation habitats in the Ohio area supported a variety of big game species, the most notable of which were caribou and mastodons (Delcourt and Delcourt 1981; Bonnichsen et al. 1985, 151; Tankersley 1993, 43; Shane 1994; Whitehead 1997; Shane et al. 2001). By 11,000BP, spruce and pine stands were pronounced throughout the Ohio region. The plant and animal community distributions were ‘disharmonious’ in comparison to modern analogs and often contained both existing and extinct species (Graham and Lundelius 1984; Guthrie 1984; Kelly and Todd 1988, 240).

The beginning of the Archaic period C.A. 10,000 B.P. lies within what Davis and Jacobson characterize as a period of “great and persistent change”. As noted above, the water levels throughout the Lake Erie basin were largely affected by the retreat of the late Wisconsinan glaciers. By roughly 9,500 B.P., water levels were on the rise as drainage systems adjusted, and water was once again rerouted through the Lake Erie basin. Mothersill and Schurer suggest that there was an “increase in surface run-off” that also promoted the development of “shallow, relatively warm-watered lakes” within the study area (2003). Regional climate was at the warmest and driest post-Pleistocene conditions around 5,000 B.P., after which characteristics trended toward modern values (Guthrie 1984). The western portion of the Lake Erie basin was reestablished in similar fashion to the modern phase of Lake Erie by about 5,000 B.P. because of the regeneration of the Port Huron outlet (Mothersill and Schurer, 2003). This is the same outlet that was draining into the Lake Erie basin at the beginning of the Paleoindian period. Fullerton (1986) notes that the water levels of Lake Erie would have been about 10m below modern day levels. The climate and environment both gradually trended towards being more predictable from a subsistence standpoint as global temperatures continued to warm. While the environmental variability noted during the Early Paleoindian time frame was linear, transcending annual
constraints; the changes noted during the Archaic period became cyclical and more related to annual seasonality and regional geography. Seasonality allowed for different floral and faunal communities to stabilize and flourish during certain parts of the yearly climatic and environmental cycle based on latitude and elevation (Guthrie 1984).

Slower changing environmental factors also bear on the pattern and intensity of Paleoindian and Archaic settlement within this study area. Using Ohio as the focal point, one can designate differences in terrain and lithic resource availability. It is assumed that each of these factors contributed to the mobility behaviors exhibited by each of the five groupings considered in the present study. Figure 1.2 Terrain map of Ohio is a terrain map that identifies the relevant differences within the study area. To the west, the terrain is generally flat in central and western Ohio. To the east, moving toward the Pennsylvania region, one can see the prominence of the western foothills of the Appalachian Mountains to the south where the unglaciated landscape is hilly with broad valleys. Figure 1.3 is a physiographic map, which makes each of the topographic regions more clear. These physiographic features created spaces where mobility would have been relatively unobstructed in the west, as well as spaces where mobility should have been constrained significantly to the east on the unglaciated plateau. Throughout the unglaciated plateau there are river valleys, which created ‘throughways’ of more passable terrain which allowed for some mobility along these corridors. While the presence of Lake Erie may appear as if it would impose a barrier to the direct north, it may have also acted as a ‘throughway’ connecting other locations, most notably western New York, within the study areas.

Finally, Figure 1.4 illustrates the locations of many lithic raw materials that were utilized by the groups within this study. This figure includes the locations of both lower quality lithic resources, as well as the coordinates for Upper Mercer and Flint Ridge Flint outcrops, two high
quality local raw materials that were predominantly utilized within the region. The distribution of
diagnostic projectile points made of these distinctive raw materials relative to their outcrop
source of origin will figure throughout this dissertation.
Figure 1.2 Terrain map of Ohio (Ohio division of Geological Survey, 2002 (2003), Shaded elevation map of Ohio – Ohio Department of Natural Resources, Division of Geological Survey Map MG-1, generalized page-size version with text, 2p. scale 1:2,000,000.)
Figure 1.3 Physiographic regions of Ohio (Ohio Division of Geological Survey, 1998. Physiographic regions of Ohio: Ohio Department of Natural Resources, Division of Geological Survey, page-size map with text, 2 p., scale: 1:2,100,000.)
Of the roughly thirteen types of cherts or flints available in the Ohio area, Upper Mercer and Flint Ridge Flint stand out as superior materials. Ultimately, these two sources allow for the extraction of large pieces of knappable flint that are relatively homogenous in structure and finely textured (Tankersley 1990; Carlson 1994; Seeman 1994, 276; Lepper, Yerkes, and Pickard)
2001, 68). All other things being equal, they allow for the most consistent production of large, symmetrical bifaces when compared to other outcrop sources. Large bifaces with good resharpening potential are an advantage for mobile populations. A more detailed explanation of each Upper Mercer and Flint Ridge Flint is provided below.

*Upper Mercer chert* was deposited within of the Upper Mercer Limestone formation of the Pennsylvanian system 320,000,000 years ago (Stout and Schoenlaub 1945; Luedtke 1992). The deposits come in many forms, including nodules, single beds, and thick, multilayered sheets (Luedtke 1992). The Upper Mercer Limestone Formation forms a southwest-northeast belt and outcrops sporadically from Hocking County, Ohio to Coshocton County, Ohio (Figure 1.5) (Carlson 1994: 213). The flint itself ranges in color from light grey to dark grey, black, and light brown (Figure 1.6) (Stout and Schoenlaub 1945). Milky white bands are present in some cases, and are caused during the formation process by fractures within the stone that are filled by quartz and chalcedony crystals. Depending on the depositional process of the Upper Mercer chert, a wide range of quality can be noted. As the chert itself becomes denser, a higher quality can be expected (Luedtke 1992). While there are locations where bands or nodules of Upper Mercer may outcrop at the surface of the landscape, there is also evidence of extraction of the raw material by prehistoric groups through the digging of large quarry pits (Carlson 1994). These pits are surrounded by debris that can also be associated with some of the groups examined in this study. The location of the most massive debris accumulations associated with quarrying and workshop activities is centered in Coshocton County, Ohio in the heavily dissected terrain of the Muskingum River watershed.
Figure 1.5 Distribution of the Upper Mercer Limestone Formation from Carlson 1994.

Figure 1.6 Examples of Upper Mercer Chert.
*Flint Ridge Flint* is another raw material that was preferentially utilized by the groups producing the projectile point styles that are the subject of this study. This flint was deposited during the middle Pennsylvanian period and is contained within the Vanport member of the Allegheny formation (Stout and Schoenlaub 1945; Converse 1973). The Allegheny formation creates a northeastern trending ovate deposit from Zanesville to Newark, Ohio (Figure 1.7) (Mills 1921). The typical Flint Ridge Flint deposits are in sheet-form with an average thickness of around 1.2m (Leudtke 1992). This particular flint can come in a wide variety of colors, including but not limited to pink, orange, yellow, white, green, brown, blue, and purple (Figure 1.8). Nether’s Flint is a variety of Flint Ridge Flint with tiger-striped banding. In lower quality versions of Flint Ridge Flint, we see pockets of quartz and chalcedony that are formed during depositional processes (Converse 1973). One unique characteristic of the flint is its level of transparency. When a light is shown through the flint, it is nearly always visible through the other side (Leudtke 1973). Flint Ridge Flint is occasionally accessible at ground level in rock outcrops, but there is also evidence of prehistoric quarry pits that provided access to buried portions of the flint deposits (Mills 1921).
Figure 1.7 Distribution of Flint Ridge Flint from Carlson 1994.

Figure 1.8 Examples of Flint Ridge Flint.
1.3 General Theoretical Context

There are three main factors that affect spatial interaction that are noted in the geographic literature; the complementarity between two places, the presence or absence of intervening opportunities, and the transferability of the resources being moved between places. Alber, Adams, and Gould (1971) note that “for two places to interact there must be a demand in one place and a supply at another, and the demand and the supply must be specifically complementary” (p.193). Within this study, the supply location would be the site of the lithic outcrop and the ‘demand’ would be the find location for the projectile point. The find location is a physical expression of the presence of the group’s demand for the resource. The complementarity is not between two populations, but rather two geographic locations. In studies regarding groups that are highly mobile, it can be assumed that the supply location provides access to a necessary resource, and demand location provides access to some other resource, be it social or subsistence based.

Intervening opportunities on the prehistoric landscape would be the availability of other lithic resources. It is this factor that can be related back to general concepts in resource geography as described by Gavin Bridge (2009). Bridge notes that “Resources… are a cultural category into which societies place those components of the non-human world that are considered to be useful or valuable in some way” (p. 1219). Bridge goes on to say that resources are “a primary social category through which we organize our relationships with the non-human world”, and that “what qualifies as a resource can vary over time and space, because it is technology and culture that confer utility and value onto materials” (p. 1220). I argue that although physically present on the landscape throughout the prehistory of the study area, not all lithic resources would always be considered intervening opportunities because they were not
deemed resources by the culture or society that encountered them. Over time, the requirements of the lithic types change based on the projectile point style. Early projectile points would have required a higher quality raw material because of the delicate construction and durability needs. Over time, projectile point styles changed; allowing for the use of lower quality raw materials. While the lower quality raw materials are intervening opportunities during the Archaic period, I would argue that they were not intervening opportunities during the Early Paleoindian period because they were simply not functional in the construction of Early Paleoindian projectile points.

The transferability of lithics can change throughout time as well, depending on the size and pathways of mobility. Alber, Adams, and Gould note that “If goods cannot move because of the high cost of movement, other goods will be substituted if possible, or people will just go without.” (1971). Transferability differs between places, between classes of movements, and between modes of movement. The large scale movement of Early Paleoindians, and their inability to be stagnant on the landscape would have supported a lower cost for visiting high quality raw material outcrops. Archaic groups would have been more reliant on the local resources of a region, and long distance commutes to gain access to high quality raw materials would have carried a higher cost; resulting in the more frequent use of locally found lower quality raw materials.

The general archaeological perspective that this dissertation explores is the commonly accepted concept that mobility decreased between 12,000 and 4,000 years ago. Mobility for the earliest group, the Early Paleoindians, is thought to have been very high as a result of the instability of the environment, resource accessibility, and low human population density. As
climatic and environmental conditions became more stable and more predictable throughout the Archaic period, mobility ranges became progressively smaller.

Although many researchers have subscribed to this general assumption, it can be traced back to the seminal work of Joseph Caldwell (1958).

“If there is any overriding pattern to be seen in the history of the East before the establishment of food production as an economic basis, it is in the evidence for increasing efficiency and success in exploiting the resources of the forest.” Caldwell states that the earliest groups were initially “oriented toward hunting the larger mammals, and others more dependent on food-gathering techniques…”, they were “characterized as more nomadic than the peoples that succeeded them”… He notes that eastern Archaic groups can be seen as “a climax of earlier lines of cultural development, that a degree of settled life was secured”, which was “a result of the development of economic systems which, while still on a hunting-gathering basis, represented a more efficient accommodation to life in the forest” (p.6).

Caldwell suggested that mobility ranges should decrease as a result of increased technological efficiency, resource familiarity, and success of human populations over time. He felt that by the Late Archaic, hunter/gatherer groups in eastern North America had developed optimally efficient patterns of exploiting or “harvesting” seasonally available resources. He referred to this as the attainment of “Primary Forest Efficiency”. Caldwell’s interpretation was largely impressionistic and not based on quantitative data. The idea however, resonated with archaeologists and can be seen in the work of many subsequent scholars beginning with Winters (1974) and Brown and Vierra (1983). Winters extends the ideas of the Primary Forest Efficiency model by discussing his proposed Harvesting Economy. Within a Harvesting Economy, one can expect the toolsets to become more refined with the introduction of specialized tools tailored to the needs presented by focusing subsistence exploitation on a smaller number of plant and animal species. Mobility for groups operating within the Harvesting Economy would have been limited, spending extended periods of time at residential camps and the distributions of these groups throughout space would
have been characterized by “denser concentrations of population in relatively small territorial units”. While Winters and Caldwell’s discussion on mobility was more implied (increased time at residential camps = decreased mobility), Brown and Vierra discuss mobility outright; stating that “…growth in population during the Middle Archaic was the result of a reduction in mobility and the emergence of new food procurement strategies and scheduling routines” (p. 168).

As noted above, it has often been accepted that mobility ranges (lithic supply zones) become more constrained over time, and if this is true, an evaluation of the distributional patterns of cultural remains should reflect this transition. In reality, this proposition has not been well tested using empirical data. Through the use of established and new directional and distance based methodologies, this dissertation will evaluate the assumption of decreasing mobility using a longitudinal dataset on the lithic supply zones; incorporating multiple groups at different temporal stages. A series of descriptive statistics and graphs were generated and Geographic Information Systems (GIS) methodologies are introduced to better understand the dataset from multiple vantage points.

By using lithic supply zones to measure mobility ranges, I gain insight into the changing size, intensity, shape, and characteristics of social networks for each group within the study over time. Using this theoretical framework as a guide for interpreting the results of this project allows for the analysis of a unique, replicable, dataset that will explore assumptions that have been posited in archaeological publications for decades. Additionally, I provide a large and unprecedented data set that can be utilized to refine the questions archaeologists ask in future work.
The following dissertation will be presented in a chapter format. Chapter 2 will provide further explanation on the literature that was used to support the development of the theoretical context for this project. The third chapter describes the methodology, specifically the techniques that were used and tested during the execution of this dissertation. Chapter 4 discusses the results and dissects the outcomes of each of the models reviewed in the methodology section. Finally, Chapter 5 synthesizes and discusses results and includes suggestions for an explanation of the results from analyzing the dataset while making connections to the literature review.
Chapter 2: Literature Review

Caldwell’s (1958) concept of the Primary Forest Efficiency Model suggests that Early Paleoindians should have the largest mobility range of any hunting and gathering groups in the archaeological past of North America, with subsequent populations ranging over smaller areas. The present study seeks to comparatively test this assumption within a single research universe using a large database. The literature review below highlights background research which has worked as a pathway in guiding the rationale for this dissertation. It is clear that most such studies have focused on Early Paleoindian, with little attempt to structure the findings in a long term comparison. This dismissal of temporal context that we find in much of the literature makes the formation of general statements on mobility in the archaeological record difficult.

Arguably one of the most impactful pieces on Early Paleoindian mobility was Kelly and Todd’s (1988) publication. Strongly based in the ecological Optimal Foraging Theory, Kelly and Todd argue that Early Paleoindians were highly mobile small groups of colonizing populations making subsistence choices based on a delicate balance that considered the time and energy expenditures associated with each food procurement activity. They characterize the group’s high mobility as one of frequent and wide-spread Paleoindian moves that mimic the mobility of the large animal species they hunted across an expansive home range, a notion that is later supported by a number of researchers, including Alvarad (2006). Figure 2.1 is a graph depicting how prey body size directly and positively correlates to group territory size.
Kelly and Todd reinforce the standard that the Early Paleoindian high mobility strategy was facilitated by the use of refined toolkits that were composed of a relatively small number of implements constructed of high quality raw materials. The authors support the notion that the distribution of these altered high quality raw materials could be interpreted as, and linked to, the home ranges of the Paleoindian hunting and gathering groups. Throughout their article, Kelly and Todd (1988) discuss in general terms the notion of home range reduction over time, using similar lines of reasoning to those noted in Caldwell’s Primary Forest Efficiency model (1958). The latter assumes that mobility ranges decrease over time because of an increased ability to manipulate ‘settling’ environmental variables. An environment that is more predictable leads hunting and gathering groups to settling on the landscape. Long-distance moves to obtain access
to resources becomes less necessary. This settling facilitates a growth in population that would be unmanageable with higher mobility strategies because the movement and mobile support of groups with larger populations is more difficult. While Kelly and Todd present a model of what the mobility ranges of Early Paleoindians should look like, they do not actually provide any visible data analysis or maps of such ranges. This type of textual and descriptive discussion of mobility range also can be found in subsequent publications on hunter-gatherer mobility, including that of Carr, Adovasio, and Pedler (1996). While useful to an extent, these descriptions or models certainly leave some room for expansion and they require more empirical testing as analytic tools advance. Two other important territoriality related articles (Gramly 1988, and Anderson and Hanson 1988) provide more concrete representations of how mobility can be visualized on the landscape for early hunting and gathering groups in eastern North America.

Gramly (1988) explores Paleoindian mobility strategies in and around eastern New York. After a review of the raw material composition of multiple Paleoindian sites within the study area, Gramly generates actual mapped borders of his hypothesized band territories. He distinguishes between bands based on the predominant raw material within the site assemblages. The resulting ‘border’ map estimates the locations of lithic supply zones for the three high quality raw material types found at the sites along major drainages within the region for Early Paleoindian group (Figure 2.2). Gramly suggests a western New York/Pennsylvania/eastern Ohio band territory of 400 x 75 km tied to Flint Ridge Flint and Upper Mercer, a central band territory of 250 x 150 km tied to Onondaga flint, and an eastern band of 350 x 140 km tied to Normanskill chert (1988: 272).
In 1994, Seeman (1994:276) expanded on these three zones to include the western extent of the Ohio Upper Mercer/Flint Ridge Flint zone for Early Paleoindians, which carried a core territory size of about 300 x 250km with lobes extending further into Michigan and New York. Seeman also provides an estimated lithic supply zone for Wyandotte flint, which is out of southern Indiana. This territory measured approximately 250 x 250 km (Figure 2.3). Gramly and Seeman’s maps of hypothesized mobility ranges were a step in the right direction of moving past the general model of Kelly and Todd (1988), but are still more impressionistic than empirical.
Anderson and Hanson (1988) focused on Early Archaic groups in South Carolina and Georgia. This study was generated using the systematic analysis of the distribution of diagnostic projectile points across the landscape. Anderson and Hanson’s research is also packaged within the context of the Optimal Foraging Theory. They note the important impact that increasing seasonality had on the mobility strategies of Archaic hunting and gathering groups in the region. More specifically, Anderson and Hanson explain that the winter months led to an aggregation of small bands in an attempt to concentrate efforts on sparsely dispersed resources. Summer brought on a more homogenous resource landscape, which allowed the larger group to dissolve. Anderson and Hanson introduce the idea of different site types and provided expectations for site types across the landscape and throughout the year. They provide designations of base camps, aggregate camps, foraging camps, and logistical camps, evaluating their mobility models against...
the known distributions of different site types in the study area. Similar to Gramly (1988) and Seeman’s (1994) studies on Early Paleoindian lithic supply zones, Anderson and Hanson distinguished bands by identifying the predominant lithic raw material type used within major drainages in the study area. The authors analyzed the distribution of nearly 600 artifacts from eight different sites. The artifacts mainly were composed of three different lithic sources. From the spatial distribution of these points, they infer that groups of smaller bands containing 50 to 150 people would reconvene at aggregation sites during the winter months, forming larger macrobands (p. 267). The boundaries of these band territories are shown as strict borders instead of gradual fall-offs with range sizes of 390 x 70 km, 390 x 80 km, 400 x 95 km, 390 x 85 km 395 x 80 km, 370 x 120 km, 300 x 105 km, and 300 x 60 km (p. 269) (Figure 2.4).

![Figure 2.4 Distribution of Archaic macroband territories. (Reproduced with permission of the Society for American Archaeology from Anderson, David G. and Glen T. Hanson. “Early Archaic Settlement in the Southeastern University States: A Case Study from the Savannah River Valley,” *American Antiquity* Vol. 53, No. 2 (April 1988): 262-286.)](image-url)
While providing an interesting and new analysis of different land use strategies and site compositions than other published projects, Andersen and Hanson lump together all Early Archaic diagnostic points, rather than separating them out by temporally specific types. This practice opens up the possibility of misinterpretation because the points in question span several thousand years.

A decade later, Daniel (2001) revisited Anderson and Hanson’s study, but with a larger dataset composed of over 2,700 points from 25 counties in both North and South Carolina (Daniel 2001: 243). Daniel’s results suggest that there are two clearly defined, large, ovate territories rather than the eight distinct territories identified by Anderson and Hanson. One territory measures about 300 x 250 km, and the other about 320 x 280 km (p. 253). Daniel argues that the territories of the Early Archaic groups transcend drainages rather than following them. Daniel’s two territories each had outcrops of high quality lithics at their core (Figure 2.5), which is quite different than the drainage based territories suggested by Anderson and Hanson.
Figure 2.5 Suggested lithic distribution for Archaic groups in the southeast from Daniel 2001 (with permission).

Group mobility may have centered on lithic quarries, but would not have been driven alone by access to the quarries. Daniel suggests that the quarry sites themselves would have served both logistical and social purpose, which is supportive of Speth’s (2012) later argument. Groups would regularly resupply while occupying camps at the quarry sites, and would periodically practice a ‘disembedded’ procurement strategy when occupying other places on the landscape. Daniel’s analysis of Early Archaic lithics provide some additional insight into the lithic distributions of Early Archaic groups within Georgia and South Carolina, but in similar fashion to the hardened borders provided in the Anderson and Hanson publication, stable decreases in lithic utilization are not represented.
Once again within the framework of the Optimal Foraging Theory and Primary Forest Efficiency, Stafford (1994) expands on the work of Kelly and Todd (1988), Gramly (1988), and Anderson and Hanson (1988) to include a more thorough understanding on how diachronic change happens with relation to hunter-gatherer mobility in North America. Stafford’s publication centers on the analysis of a sample of over 900 diagnostic Archaic hafted bifaces that were found within the Midwest and more specifically, in southwest Indiana (p. 229). Stafford’s results suggest that, over time, Archaic groups shifted towards the use of high quality subsistence resource patches, moving from a broad-ranging foraging pattern characterized by frequent residential moves, to a more “collector” pattern with large, semi-permanent multi-season base camps with small resource extraction task groups. Stafford notes that further evidence of this shift is provided by a general lack of base camps during the earlier part of the Archaic period. Early Archaic groups routinely used the landscape, moving in small groups from resource patch to resource patch. Later Archaic groups were more specific in their focus on the intensive utilization of resource patches adjacent to high order streams (p. 232). Stafford’s publication sets a precedent of understanding mobility transitions through the actual review of multiple group’s mobility strategies. Unfortunately, Stafford does not present any models, graphs, or charts that actually display the changes in mobility ranges that were discussed.

Cantin (2000) utilized much of the data from Stafford’s research, but with more detailed and better documented analysis of temporal change. This publication provided testable and replicable results. Cantin introduced the use of fall-off curves to understand how lithic supply zones behave across space and across archaeological phases. No longer bound to the strict constraints of the ‘borders’ presented in the studies above (Gramly 1988, Anderson and Hanson 1988, Seeman 1994), Cantin provided a quantitative analysis of Wyandotte (W) and non-
Wyandotte (NW) lithics across distance for Early Archaic Thebes points and for slightly later Early Archaic Kirk corner notched points which resulted in replicable fall-off curves (Figure 2.6). There were 83 Thebes cluster points and 287 Kirk cluster points in the dataset (p. 57). He notes that the later Kirk groups were more likely to utilize local raw materials than Thebes groups; and that when the Kirk groups used Wyandotte, they were typically at distances further from the quarry site. Cantin postulated that the Kirk and Thebes home range extent would have been up to 150km, noting the sharp decline after 150 km in both datasets as evidence supporting this notion. Cantin is also concerned with interpreting the different patterns of tool modification, recycling, and salvaging that can be expected for different places on the landscape.

Figure 2.6 Fall-off curves for Thebes and Kirk points from Cantin 2000.
This study finds that the fall-off curves don’t differ drastically between the Thebes and Kirk phases, however there are notable differences in the discard behaviors around the outcrops. Kirk points are discarded within 0-50kms of the quarry at a substantially higher rate than the slightly earlier Thebes points (p. 64). These results indicate the increased utilization of more local raw materials over time. Cantin’s publication also supports Caldwell’s Primary Forest Efficiency model, suggesting that subsistence pursuits broaden over time as a result of the rapid changes in the environment. One weakness of the utilization of the fall-off curves presented by Cantin, however, is that no consideration is given to the directionality of movement within the lithic supply zones, only distance.

Ellis (2011) utilizes similar methods of representation to those of Cantin (2000) to review the change in mobility patterns between the Early Paleoindian period and the later Paleoindian period in the Great Lakes area. Rather than creating fall-off curves based on single point identifications like Cantin (2000), Ellis creates these curves based on the predominant raw material used within 83 separate sites in effort to minimize the effects of possible exchange systems (p. 386). Ellis also begins to build an appreciation of the effects of directionality on long distance movements between the two phases. Ellis doesn’t map the movement on the landscape, but similar to Cantin, created bar graphs for both distance and direction. The results indicate that the Clovis-like Paleoindian groups were more likely to range farther away from the raw material source than later Paleoindian groups (p. 395) (Figure 2.7).
Figure 2.7 Fall-off curve for Paleoindian projectile points from Ellis 2011 (with permission).

The fall-off curves, once again, provide a better description of how the raw material patterns appear over space than the more subjective ‘borders’ created in earlier works. Ellis suggests that it was not uncommon for Early Paleoindian groups to move raw materials in straight line distances of between 175-200km or more (p. 397). Ellis also evaluates the difference in the directionality of movement by creating bar graphs that illustrate the direction from site to the source where the main raw materials originated. Ellis notes a north-south mobility for the Paleoindian period, which is more intense during the earlier Paleoindian phase than during the later Paleoindian phase. While the conclusions of this publication are a step toward incorporating the two logistical components of mobility (distance and direction), they do not provide the same visual effect that maps can provide.
Several other publications also make attempt to introduce the importance of both distance and direction of movement into the analysis of lithic supply zone data, while providing cartographic representations of their findings. Holen (2001) maps out size, shape, and direction of Clovis mobility through the distribution of different lithics throughout the High Plains (Figure 2.8). He suggests that while many different mobility strategies could have been at play, the most common would have been the large scale, seasonal movement of the Clovis groups from the foothills to the Plains in the spring. The groups would have moved into the protection of the valleys during the fall and winter months.

Figure 2.8 Distribution of White River Group Silicates from Holen 2001 (with permission).
Holen notes the idea that in the west, bison composed a large portion of the Paleoindian diet. Supporting the ideas presented by Daniel (1998) and later by Speth et al. (2013:112), Holen suggests that lithic quarries served as a point on the landscape that facilitated band interactions “because Clovis bands became dependent on highly mobile faunal resources, and were themselves highly mobile, there was a need for a reference point on the landscape in order to interact with other Clovis bands” (p.214). While Holen’s vectored representation of Clovis mobility does incorporate size, shape, and direction of mobility, without hardened boundaries, the statements are supported by educated conjectures rather than methodically processed data.

White (2012) creates similar vector-type maps to those generated by Holen (2001), but looks more acutely at raw material transport by connecting projectile point find locations to the geographic center of all points with a common raw material source rather than connecting the find locations of the points directly to their raw material outcrop. White creates vectored maps for a number of Paleoindian and Early Archaic point types, including nearly 500 early fluted points (Figure 2.9) and 500 Thebes points (Figure 2.10).
Figure 2.9 Distribution connecting find location of Paleoindian points with the weighted center of their raw material source from White 2012 (with permission).
He notes that the Early Paleoindian sample is associated with relatively large raw material transport distances. Regionalization does not seem to be visible in this case of the Early Paleoindian dataset. The results show strong similarities to that of the Early Archaic regarding raw material distributions. Increased regionalization, however, is apparent in the case of the Thebes cluster, as the distribution of Thebes points depicts very little overlap in transport of raw materials. White’s maps provide quantitatively supported representations of the size, shape, and direction of raw material transport, but graded ‘boundaries’ of lithic supply zones are still difficult to extract.
Recently, Aagesen (2010) utilizes projectile point distribution data from the Paleoindian Database to explore mobility and lithic supply in the northeastern region of North America, an area previously discussed and modeled by Gramly (1988). Aagesen’s estimation for Early Paleoindian territories is more of a quantitative analysis than Gramly’s previous presentation of home ranges (Figure 2.11). She incorporates multiple Exploratory Spatial Data Analysis techniques through the use of the ESRI’s Geographic Information System software ArcMap 9.2.

Figure 2.11 Estimated territories for Early Paleoindian groups from Aagesen 2010.

Aagesen used the LISA clustering function within ArcMap 9.2 to identify regions within her study area where distinct clustering patterns were present. Clusters were identified when running the LISA function for raw material types. Aagesen also quantifies movement by incorporating the directional mean function. This function creates statistically generated vectors that indicate the direction of transport of a raw material from its outcrop source. Aagesen combines the results
from her Exploratory Spatial Data Analyses to designate 5 ‘proposed territories’ for the Great Lakes and North East region of North America for Early Paleoindian groups, including the Ontario territory, Ohio territory, New York/Pennsylvania territory, Virginia territory, and New England Territory, with estimated respective areas of 600km x 300km, 600km x 300km, 400km x 600km, 350km x 400km, and 600km x 600km, which are considerably larger than the ranges estimated in some of the previous publications.

It is also important to note Mullett’s (2009) research on Early Paleoindian lithic supply zones, as it was a driving force in the exploration of mobility range across time. The focus of this work utilized the GIS Kriging interpolation function to better understand and estimate the lithic supply zones for Upper Mercer and Flint Ridge Flint during the Early Paleoindian phase in the study area which included present day Ohio, New York, Pennsylvania, West Virginia, Kentucky, Indiana, and Michigan. The study used the distribution of over 1,300 Clovis and Gainey projectile points to map the fall-off of the two raw materials from their outcrops and across the landscape (p. 34) and found that the fall-off to the east of the outcrops was characterized by patterns of sharp declines followed by plateaus (Figure 2.12).
Figure 2.12 Early Paleoindian lithic supply zone for Upper Mercer and Flint Ridge Flint from Mullett 2009.
The fall-off to the west of the outcrops was much more gradual over space. While the results from the thesis identified patterns in the east-west movement of raw materials, there was not enough data to support conclusions on north-south movement. The mobility range was described as an area where either Flint Ridge Flint or Upper Mercer flint composed more than 60% of the dataset. Results from the interpolation estimated a lithic supply zone of about 200 km² (p.76).

This research presented two ideas for expansion, first, adding data from the northern and southern portions of the study area and second, adding data from different archaeological phases to allow for a temporal analysis to better understand mobility range reduction.

Though each of these publications have worked towards a better understanding of lithic supply zones, mobility strategies, and group behavioral choices of early hunting and gathering groups, none provide a systematic and diachronic outline of the change in size, shape, and intensity of lithic supply zones throughout the early periods of North America’s settlement by human societies. This dissertation attempts to utilize and expand upon the methods used in the past to better understand the commonly accepted stance that lithic supply zones, and thus mobility ranges, get smaller over time.
Chapter 3: Methodology

Methods used for this study fall into four categories: 1) point collection and identification; 2) accuracy assessment; 3) traditional and “impressionistic” methods and 4) geospatial methods. Point collection and identification was necessary because there were no existing datasets that provided both the regional expanse and temporal depth needed for this project. Once the datasets were compiled, an accuracy assessment was conducted to determine which interpolation method could most closely estimate unknown values for the spatial data. It was also important to combine previous ‘impressionistic’ methodologies with the newer geospatial methods to gain a fuller understanding of the spatial distributions of this temporal data. I have included a more in-depth description of these methods throughout this chapter.

3.1 Point Collection and Identification

Data collection from the archaeological perspective is a process that could continue indefinitely since samples exist in many formal and informal collections. It took about two years to collect enough data on the five projectile point types to support the methodologies for this research. Projectile point data were accumulated from both primary and secondary sources. The primary source for these projectile points was from existing projectile point assemblages housed in museums or artifact collections belonging to collectors. Some of the smaller collections only required a single visit, while some of the larger collections were revisited multiple times over several months. Museums visited include: Cleveland Museum of Natural History, Ohio
Historical Society, Cincinnati Museum Center, Boonshoft Museum of Discovery, Hopewell Culture National Park, and the Mahoning Valley Historical Society. Some of the larger personal collections that were reviewed belonged to Charlie Fulk, Dave Snyder, and Larry Morris. Secondary sources were also utilized to supplement the datasets collected through primary exploration of point assemblages. Secondary sources for this project include records of points that were previously published in books, journal articles, site reports, theses, and dissertations. Precautions were taken to ensure that no point was counted more than once within each point dataset. Since this study largely relies on spatial distributions, projectile points were only added to the point spreadsheets if the ‘find’ location could be sourced to at least the county level.

To prepare for the data collection process, I had intensive training from Dr. Mark Seeman and Charlie Fulk in the identification of the study area’s projectile point types and raw material sources. There is precedence set for the use of visual identification of lithic raw materials in archaeological research. There are alternative methods, such as neutron activation analysis, that have also been used to chemically attribute a source for a raw material sample, but this process is not practical for several reasons with regards to this project. The first is the fact that these chemical analyses are destructive techniques, which requires the damaging of prehistoric artifacts in order to have a sample to analyze. The techniques are also expensive and time consuming, and it was simply not financially possible to support the processing of the thousands of projectile points contained in the datasets that I’ve compiled. To lend support (in addition to the precedence set in the archaeological literature) to the use of visual identification of lithic raw materials, I refer to the publication by Boulanger et al. (2014) that compares the visual identification of raw materials from the Paleo Crossing site in Ohio to the identification results of neutron activation analysis. This study essentially provides ‘geochemical verification’ for the
previously visually identified lithic raw materials – confirming that the visual identification was accurate.

The study area for this project extends across the lower Great Lakes region and includes Ohio and its surrounding states. The time period of focus includes the initial occupation of the area (around 11,500 BP) until about 4,000 BP (Early Paleoindian period until the late Middle Archaic period). One way to distinguish between archaeological phases in the region is through the identification of unique artifacts. For this dissertation I focus on the distribution of five time-specific projectile point styles: Clovis/Gainey, Thebes, MacCorkle, LeCroy, and Brewerton Corner Notched. Projectile points were hunting implements that were predominantly made of lithic (stone) resources during the time in question. The figure below illustrates the total number of points that I have in the dataset for each projectile point type (Figure 3.1).

![Total Points In Dataset](image)

**Figure 3.1 Total points used for this dissertation.**
These five projectile point types were selected for a number of reasons. Not only were each of the point types found throughout the entire study area, they also span the Paleoindian and Archaic Periods representing minimally 7,000 years of time depth. While these point types meet the temporal and spatial preferences for the project, they also are relatively easy to identify. Clovis/Gainey, Thebes, MacCorkle, LeCroy, and Brewerton points are all distinct in style, making type identification more reliable. Finally, these point types pertain to a period when trade or exchange of raw materials is a less likely cause of raw material dispersal across the landscape. While exchange on a smaller scale is still conceivable, it is unlikely that the movement of a majority of the lithic material during this timeframe was due to trade. It is my assumption that the distribution of lithics across the landscape is due predominantly to direct procurement from the lithic outcrops (Tankersley 1990).

3.1.1 Clovis/Gainey (11,500-10,900 B.P.)

Clovis and Gainey fluted points are found throughout the Great Lakes region of eastern North America; spanning an occupation period that radiocarbon dates to between 11,500BP and 10,900BP (Tankersley 1998; Waters and Stafford 2007). Some archaeologists support the idea that these two point types come from the same complexes because the stylistic differences are not exceptionally distinct. Others see them as a temporally related continuum of stylistic characteristics rather than two specifically diagnostic point groups (Loebel 2005). The differences between Clovis and Gainey styled points is subtle and relates to matters of projectile point preparation, the depth of the basal concavity, length and complexity of fluting (intentional removal of lithic material from the base of the projectile point towards the distal portion (top) of the point), and cross-section shape. Clovis points have been identified across the whole of North America whereas Gainey points seem to be geographically restricted to the eastern portion of the
continent and centering on the Great Lakes region (Waguespack and Surovell 2003). The Clovis/Gainey complex(es) is generally associated in the archaeological literature with extremely high mobility due to low human population densities and the use of highly mobile big game resources such as caribou (Haynes 1980; Kelly and Todd 1989; Loebel 2005). Many stone tools associated with this timeframe are found at distances upwards of 250km or more from their raw material outcrops (Hoffman et al. 1991; Koldehoff 1999; Loebel 2005; Jeske 2008). Anderson and Gillam (2001) suggest that this subset of Paleoindian foragers constructed large territories that would ensure access to both subsistence resources as well as access to high quality stone quarries.

The construction of Clovis and Gainey points typically required the use of a large, bifacial core technology (Morris et al. 1999). The reduction techniques utilized to produce a Clovis or Gainey point from these cores is strategic and well-engineered. Typically lifespan of these points is comparatively long; a majority of these points that are found have been exhausted after many rounds of resharpening, a process used to extend the use-life of a point and hence to enhance mobility by decreasing the need to resupply. Figure 3.2 provides a visual model of the use-life of Clovis/Gainey points from specific cases in my dataset. The point directly to the left is moderately used, while the point to the right is exhausted and has been resharpened until it is no longer functional as a hunting implement.
It is important to reiterate that later Clovis points are very similar to early Gainey points and distinctions are difficult, if not impossible, to make. Standard Clovis point characteristics include lancelet shape, outré-passe flake patterning (where the horizontal flaking extends across the midline of the projectile point), ‘stubby’ flutes (sometimes multiple flutes on the same side) extending only about 1/3 to 1/2 of the way up an original Clovis form, straight to slight basal convergence of ground lateral margins, and a slight basal concavity (Morris et al. 1999; Morrow and Morrow 2002). Gainey points are very similar in morphology to Clovis points, but are occasionally identified as different style types because they are typically slightly smaller with a deeper basal concavity and a longer flute. When looking at individual projectile points, we are
often faced with descriptions of individual points being “more Clovis” or “more Gainey” and points on a Clovis-Gainey spectrum rather than defined as Clovis or Gainey.

3.1.2 Thebes (10,000-9,000 B.P.)

Thebes points do not directly follow Early Paleoindian points on the archaeological timeline for the study area. They occur during the Early Archaic period, and radiocarbon date to between 10,000 and 9,000 BP (Emerson et al. 2012; Stafford and Cantin 2012). The geographic distribution of Thebes points centers on Ohio, Indiana, and Illinois, and stretches into Missouri, Kentucky, West Virginia, Pennsylvania, and Michigan (Fitting 1970; Justice 1987).

Thebes points were originally defined by Winters in 1968. These Early Archaic points also exhibit unique qualities (Figure 3.3). One defining characteristic of a Thebes point is the base of the projectile point. They have massive, broad bases which lie beneath large, well-developed side or diagonal notches. The proximal basal margin is heavily ground, resulting in a dull edge. Thebes blades are triangularly shaped with straight to convex, frequently serrated edges. As with the Clovis/Gainey projectile points, the lifespan of a Thebes point continues long after initial construction. Thebes points are commonly found resharpened to a point of exhaustion, and most often present beveling on the blade margins as a result of this distinctive resharpening technique.
Figure 3.3 Examples of Thebes points.
3.1.3 MacCorkle (9,000-8,500 B.P.)

The geographic distribution of MacCorkle points centers on Ohio, West Virginia, Kentucky, and Indiana; and extends into Michigan, Illinois, Tennessee, Pennsylvania, and New York. These points are found during the Early Archaic period and are radiocarbon dated to between 9,000BP to 8,500BP (Justice 1987).

MacCorkle points are also distinct in appearance and maintain a few characteristics that make identification relatively simple (Figure 3.4). These large points are heavily bifurcated at the base, and their basal ears are well rounded. Basal grinding is usually present and the blade faces usually contain a random flake scar patterning. The resharpening techniques used to extend the lifespan of MacCorkle points often disrupts the sporadic flake scar patterning of pressure flaking and leaves the projectile point with a serrated blade edge. Beveled resharpening is not characteristic. MacCorkle points were found above Kirk-Corner Notched points at the St. Albans site in West Virginia, suggesting a temporal placement relatively late in the Early Archaic period (Broyles 1966).
Figure 3.4 Examples of MacCorkle points.
3.1.4  LeCroy (8,500-7,800 B.P.)

Temporally, LeCroy points have been dated to the timeframe immediately following MacCorkle points, with radiocarbon dates ranging between 8,500 BP and 7,800 BP. The geographic distribution of LeCroy points is centered on the study area for this project in the Ohio River Valley (Justice 1987).

While this point type is bifurcated in a fashion similar to MacCorkle points, LeCroy points are much smaller with a very thin cross-section and more delicate basal bifurcations. Many are made on discarded flint flakes. The straight to slightly expanding bifurcated base of the LeCroy point has well-developed lobes with intentional notching. The blade edges are often serrated and can be straight, convex, or concave; depending on the stage of resharpening. Figure 3.5 provides examples of what LeCroy points look like throughout their use-life.

Figure 3.5 Examples of LeCroy points.
3.1.5 Brewerton Corner Notched (5,000 – 4,000 B.P.)

The final component to the projectile point survey is the Brewerton Corner Notched point. Brewerton point distributions are centered in Ohio and Pennsylvania, and are also found in New York, Massachusetts, Indiana, Illinois, and Michigan. These points were defined by William Ritchie in New York and are radiocarbon dated to between 5,000 BP and 4,000 BP (Justice 1987). Brewerton Corner Notched points have generally been dated with single radiometric dates from given components.

Brewerton points have a few characteristics that make them distinguishable from other medium sized corner notched points found in the region (Figure 12). Brewerton points typically have well-developed corner notches above a slightly concave or convex base. The margins of the ears are always wider than the margins of the base, and the blade exhibits sporadic, random flake patterning throughout. Occasionally, there is light grinding on the base of Brewerton points. Serrations on the blade of the point are never present and would be indicators of a different projectile point type completely. The resharpening techniques used on Brewerton points often resulted in a pentagonal blade shape. It is very common to see the use-life of a Brewerton point extended by converting it from a hunting implement into an endscraper, as is the case with the point on the far right in Figure 3.6 below.
3.1.6 Data Organization

For this project, there are a total of five datasets; Early Paleoindian Clovis/Gainey, Thebes, MacCorkle, LeCroy, and Brewerton. The datasets for each of the five projectile point types contain uniform variables to allow for across the board comparisons. These variables included point identification numbers (to protect against point duplication in the datasets); point type; raw material type; and county level provenience. The maps that were generated illustrate the relative densities of Upper Mercer and Flint Ridge Flints throughout the study area for each projectile point type. To attain information regarding relative density, the total number of each projectile point type was identified within each county, and then the total of each projectile point in that county manufactured from Upper Mercer or Flint Ridge Flint was also noted. To lessen the bias of small sample size for certain areas and possible misrepresentations because of only having a single point from some counties, counties were only included in the interpolation if they
contained at least five projectile points. The maps below indicate how many of each point type came from the counties in the study area, and represent the counties that were used for the interpolation analyses (Figure 3.7, Figure 3.8, Figure 3.9, Figure 3.10, Figure 3.11).
Figure 3.7 Distribution of counties with more than 5 Clovis/Gainey points in dataset.
Figure 3.8 Distribution of counties with more than 5 Thebes points in dataset.
Figure 3.9 Distribution of counties with more than 5 MacCorkle points in dataset.
Figure 3.10 Distribution of counties with more than 5 LeCroy points in dataset.
Figure 3.11 Distribution of counties with more than 5 Brewerton points in dataset.
The general spreadsheets for each projectile point type were imported into ArcMap 10.1, summarized to determine how many projectile points were from each county, and then summarized again to identify the percentage of the points from each county that were constructed of Upper Mercer or Flint Ridge Flints. These new database files were then joined to a county polygon shapefile. I then converted the polygonal shapefiles of the counties into point files using the *convert feature to point* tool (which places a centroid in the weighted center of each county polygon). Examples of how this new point shapefile would be displayed in the software are listed above the county distribution maps above and the raw number of counties used for each interpolation is shown below in Figure 3.12.

![Total Counties in Interpolation](Figure3_12.png)

**Figure 3.12 Total counties in interpolation.**
3.2 Accuracy Assessment

Before the interpolation function was executed on all of the datasets, it was necessary to complete an assessment of the available interpolation methods. Multiple interpolation techniques are available for researchers to use through ESRI’s ArcMap 10.1 software. The goal of interpolation is to create an estimated, or modeled, surface from a series of known data points. Each of the functions work best in cases where there is a higher quantity of known points on the landscape, but some of the functions that are available require fewer known data points by incorporating trend analysis. Certain methodologies account for changes in value simply as a result of distance between known points and estimated (interpolated) on a surface. Other functions allow the researcher to execute a trend analysis on the available data. Those trends are then incorporated into the process of estimating the interpolated surface. For this project, two interpolation functions were tested, Inverse Distance Weighted (IDW) and Kriging, to determine if one method was a better fit over the other.

At the time of the interpolation assessment, the Early Paleoindian dataset was far more complete than any of the other point datasets. The interpolation methods were compared with one another to determine if one more accurately predicted the percentage of Upper Mercer or Flint Ridge Flint Clovis or Gainey projectile points. The framework of the interpolation assessment was to create a database that could represent the known values for Upper Mercer or Flint Ridge Flint densities in counties, the value estimated using IDW, and the value estimated using Kriging. To create this dataset, the values for randomly selected ‘known’ counties were first removed from the interpolation dataset, and then estimated using both IDW and Kriging. This process was done on 100 randomly selected sets of counties where three counties with
known values were removed (see section 3.2.2.1 below). The resulting values were then compared with the recorded values from each county.

### 3.2.1 Interpolation Methods

There are multiple interpolation options available through ArcMap 10.1. The two that were selected to process this dataset are Inverse Distance Weighted and Kriging. The goal of any interpolation method is to use a series of points with known values to create a surface of estimated values. In this case, county level percentages of two commonly used Ohio raw material sources were used to build a distributional model for the lithic resources over different time periods. There are *deterministic* interpolation methods (IDW) and there are *geostatistical* interpolation methods (Kriging). Deterministic methods estimate unknown values solely based on the locations of points with known values. Geostatistical methods are able to estimate unknown values based on the values of known points in addition to the spatial arrangement of the points with known values.

#### 3.2.1.1 Inverse Distance Weighted

Inverse Distance Weighted, or IDW, is a function found in the Spatial Analysis toolset of ArcMap 10.1. The algorithm behind IDW uses a series of known points, and the proximity of those points to other known points, to estimate a value surface. With this method, errors can be assumed to be minimized if the estimated point is closer to more known values. This algorithm is based on Tobler’s law which states that while everything is related, things that are closer to one another are more related than things that are further apart. IDW is a *deterministic* interpolation method which only considers distance between points with known values for the estimation of unknown points on a surface. Surfaces that have been estimated using IDW are affected by the
spatial arrangement of the dataset. If the data is clustered in one area, the IDW results will be more reliable within the cluster, and less reliable in regions that are deficient in points with known values.

The IDW surface is estimated using a series of points with known values. A pixilated raster is essentially laid over the vector surface, and the values for the centroids of the raster are calculated using an algorithm that derives values from the known vector data. The algorithm can be adjusted by making changes to the settings within the IDW tool. One can make adjustments to the raster output cell size, type of search being used (fixed or variable), total number of points used to calculate centroid values, and bandwidth distance used for searching for points to calculate centroid values. For the initial portion of the assessment comparing IDW and Kriging, the default settings for both tools were maintained which allowed the search radius to be variable, but the estimation of the point value to be based off of the 12 nearest known points with known values.

### 3.2.1.2 Kriging

Kriging is a geostatistical interpolation method that predates the development of GIS software. The goal of Kriging is to create the best value estimation for unknown points based on the spatial distribution and values of known points. Kriging “fits a mathematical function to a specified number of points … to determine the output value for each location” (Seeyan 2014, 5). This process identifies spatial trends in the dataset and uses that information to estimate unknown values. Kriging considers both *distance* and *direction* when estimating a surface layer.

The execution of the kriging interpolation function is a multistep process. First, the process determines the spatial autocorrelation of the points and their values to determine rules of
dependency for the dataset. The points and values in the dataset are then utilized to create a semivariogram. The semivariogram is used to determine the spatial relationships between points by squaring the difference between two points, and dividing that product by the measured distance between the two points. The best fit model is applied to the dataset.

There are three parts to a semivariogram that allow us to determine the best fit model (Figure 3.13). From left to right on a semivariogram, the nugget is where the distance between two points is “0”, and the difference squared between those two points is as close to “0” as possible (Figure 3.14). The range section of the semivariogram is the portion where distance has a clear impact on the difference between the two points. Finally, the sill is where distance no longer has a predictable impact on the differences between the point values.

Figure 3.13 Kriging distance versus semivariance from ESRI.
Figure 3.14 Kriging semivariogram from ESRI.

It appears that the dataset will most closely replicate the *spherical model*. With the spherical model, the sill is easily distinguished from the other portions of the semivariogram. With reference to the datasets, once a certain distance threshold is met, it can be assumed that the difference in the values of the two points is no longer directly influenced by that distance.

### 3.2.2 Dataset description

The Early Paleoindian dataset was selected to assess the accuracy of both interpolation methods. The points for this dataset were found in Kentucky, Indiana, Michigan, Ohio, Pennsylvania, and West Virginia. Many of these points were taken from secondary sources, such as Tankersley (1990) and Fogelman and Lantz (2006), but some were recorded during the Early Paleoindian point survey conducted by Dr. Mark Seeman and myself. The Early Paleoindian
dataset was selected because, while unavoidably always incomplete (which is the nature of archaeological data), it was the most comprehensive survey of each of the project’s points for the study area at the time of the analysis. There were a total of 1667 Early Paleoindian points used for this analysis, and the interpolation was executed using the centroids for the 93 counties that contained at least 5 Early Paleoindian projectile points.

3.2.2.1 Random sampling of the dataset

One hundred random sample datasets were created from the original Early Paleoindian dataset using the Random Sample Generator in SPSS (Statistical Package for the Social Sciences. The interpolation was run on 90 counties (3 were randomly selected in SPSS to be excluded and estimated using interpolation). Once the interpolation (IDW and Kriging) was run on the 100 newly derived Early Paleoindian datasets, the differences in known and estimated values using IDW and Kriging were compared.

3.2.3 Execution of interpolation assessment, building a new accuracy dataset

To test the accuracy of the surface estimation of IDW and Kriging, the known values for three counties were removed from the dataset multiple times, creating 100 new datasets for Early Paleoindian projectile point distributions. Referring back to earlier in this chapter, it is important to note that my complete dataset had 93 counties that could be used for interpolation. Each of the 100 iterations of my test datasets contained 90 counties that would be used for interpolation, leaving three counties with recorded values that would now be estimated using the interpolation tools. Inverse Distance Weighted and Kriging were run on the new datasets, and the resulting estimated value for ‘unknown’ counties on the surface was compared to the recorded value listed in the original Early Paleoindian dataset. This information was then recorded and placed into
tables. Some important results to note are that Inverse Distance Weighted and Kriging both estimated the unknown county value more closely about half of the time (Table 3.1). Inverse Distance Weighted more closely estimated the county value for 155 counties, and Kriging more closely estimated the value for 145 counties. If the county value was over-estimated or under-estimated, each of the interpolation functions estimated in the same direction 88.67% of the time. Both functions were about 1.5 times more likely to overestimate the unknown value than to underestimate the unknown value.

**Table 3.1 IDW versus Kriging accuracy estimations.**

<table>
<thead>
<tr>
<th></th>
<th>IDW</th>
<th>Kriging</th>
</tr>
</thead>
<tbody>
<tr>
<td># of times tool was closer to estimating county value</td>
<td>155</td>
<td>145</td>
</tr>
<tr>
<td>% of the time tool was closer to estimating county value</td>
<td>51.67</td>
<td>48.33</td>
</tr>
</tbody>
</table>

A majority of the estimated values for unknown counties were within 20% of the recorded known values for those counties in the original dataset (Table 3.2). While neither interpolation method is exact, they do both provide new methods of regional analysis for archaeologists attempting to understand large scale mobility strategies.
Table 3.2 Number and percent of ‘unknown’ counties in assessment with interpolated value within 5%, 10%, 15%, 20%, or 25% of known value.

<table>
<thead>
<tr>
<th>IDW</th>
<th># of counties</th>
<th>% of counties</th>
<th>% including lower intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td>+/- 0 – 5%</td>
<td>56</td>
<td>18.6666</td>
<td>18.6666</td>
</tr>
<tr>
<td>+/- 5.01 – 10%</td>
<td>33</td>
<td>11</td>
<td>29.6666</td>
</tr>
<tr>
<td>+/- 10.01 – 15%</td>
<td>42</td>
<td>14</td>
<td>43.6666</td>
</tr>
<tr>
<td>+/- 15.01 – 20%</td>
<td>47</td>
<td>15.6666</td>
<td>59.3332</td>
</tr>
<tr>
<td>+/- 20.01 – 25%</td>
<td>18</td>
<td>6</td>
<td>65.3332</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Kriging</th>
<th># of counties</th>
<th>% of counties</th>
<th>% including lower intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td>+/- 0 – 5%</td>
<td>41</td>
<td>13.6666</td>
<td>13.6666</td>
</tr>
<tr>
<td>+/- 5.01 – 10%</td>
<td>36</td>
<td>12</td>
<td>25.6666</td>
</tr>
<tr>
<td>+/- 10.01 – 15%</td>
<td>61</td>
<td>20.3333</td>
<td>45.9999</td>
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<tr>
<td>+/- 15.01 – 20%</td>
<td>39</td>
<td>13</td>
<td>58.9999</td>
</tr>
<tr>
<td>+/- 20.01 – 25%</td>
<td>23</td>
<td>7.6666</td>
<td>66.6665</td>
</tr>
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</table>

3.2.4 More Detailed Evaluation of the Interpolation Assessment

As identifiable by the tables above, Inverse Distance Weighted recorded closer estimates for the sample counties 55% of the time. The difference between the results for the two different interpolation methods was much less than expected, so further research was needed to determine what was happening with the datasets. It was determined that while Kriging incorporated the important directional factor into the trend surface analysis of the datasets prior to executing the interpolation function, my datasets lacked the necessary scalar requirements to allow this directional component to have an impact. As is the case with many archaeological collections, the finest find-location provenience that I was able to record for projectile points in this dataset was at the county level. As reviewed above, the data was recorded at the county level, and then that data was superimposed as a value on a county centroid. The use of centroids reduces the usefulness of Kriging because it essentially removes the value of the actual data point locations.
Because of this factor, Inverse Distance Weighted was used to calculate the lithic supply surfaces for this project. While the default settings have been utilized by many researchers, it was my wish to determine if there was a specific group of settings for the IDW tool that estimated the values of known sample counties more accurately than the standard tool settings.

Table 3.3 identifies the modifications that were made for each iteration of the IDW settings assessment. The Inverse Distance Weighted function was then run on Random Sample Groups 1-10 from the steps noted above in the IDW versus Kriging assessment. A total of 8 different settings groups were defined and the results for these interpolations were then compared to the results from the IDW interpolation with the default settings. These relative results for each settings group were then ranked from “1” to “8”, “1” being the result closest to the known value for the random sample county, and “8” being the least accurate result. The rankings of “1” to “8” were relative rankings between the setting groups. A rank of “8” would indicate that that group’s settings was least accurate in estimating the value for the listed county. Table 3.4 provides a record of the ranking for each settings group for each county interpolation.

<table>
<thead>
<tr>
<th>Table 3.3 IDW Settings</th>
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<tbody>
<tr>
<td>Power</td>
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<tr>
<td>Default</td>
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<tr>
<td>Setting Group 1</td>
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<td>Setting Group 2</td>
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<td>Setting Group 3</td>
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<tr>
<td>Setting Group 4</td>
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<td>Setting Group 5</td>
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<tr>
<td>Setting Group 6</td>
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<tr>
<td>Setting Group 7</td>
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</table>
After the first five settings groups were assessed, it was noted that the results from Settings Groups 2 and Settings Group 5 (using at least 20 point and searching at least 200km for points) were the most accurate settings for my datasets. I then combined the two setting modifications together within the same interpolation for Settings Group 6. For group 6, the interpolated value of the unknown points was estimated using the nearest 20 counties with known values within 200km. If there were not 20 counties with known values within 200km, the search radius would have automatically extended to include the nearest 20 counties with known values. Settings Group 7 was also used to see if increasing the search radius to a fixed distance of 300km would increase accuracy for all estimated values. It did not. As indicated in the results for the settings group assessment below (Table 3.4), Settings Group 6 more closely estimated the known value more frequently than any other settings group. These settings will be utilized in the Inverse Distance Weighted interpolation of all point type distributions. There were only 12 counties with known data values for the MacCorkle dataset. For the interpolation of the MacCorkle projectile points, the interpolation function used all 16 counties up to 200km for estimating unknown values.
Table 3.4 IDW Setting Assessment.

<table>
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<tr>
<th>Random Sample Group</th>
<th>Default Settings</th>
<th>Setting Group 1</th>
<th>Setting Group 2</th>
<th>Setting Group 3</th>
<th>Setting Group 4</th>
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3.3 Traditional and “Impressionistic” Methods

Non-directional studies of group mobility are often done using archaeological material. These studies most often look at the regional distribution of lithic artifacts within a defined study area in relation to the distances from their raw material source outcrops. This methodology can be expanded and used to present another point of comparison between temporal groups in the archaeological record.

3.3.1 Graphical display of non-directional distance data

In much of the literature discussing early mobility structures, researchers use graphs to represent a non-directional analysis of lithic distributions. These graphs typically compare the percentage of a lithic raw material type for period-distinctive artifacts versus the measured straight line distance between the find location for the artifact and its lithic outcrop’s location. Figure 3.15 illustrates a hypothetical fall-off curve for a hypothetical raw material over three time periods (early, middle, and late).
3.3.2 Mapped display of non-directional distance data

Another way to represent these datasets is to superimpose concentric circles representing each distance interval around the Upper Mercer and Flint Ridge Flint outcrops. By mapping out the graphical information determined from the above methodology, it may be easier to see changes in distributions over time and distances. Below are two examples of the mapped display of non-directional data. The first represents a gradual fall-off from the central source. One could expect a gradual fall-off of raw materials from a lithic source in situations where the raw material was utilized as heavily at further distances from the source. (Figure 3.16). Figure 3.17 presents a more ‘steep’ fall-off. This type of distribution would be indicative of a more concentrated and localized use of a particular raw material source.
Figure 3.16 Example of hypothetical map of a gradual fall-off at 50km intervals.
Each of these non-directional approaches to understanding mobility in the archaeological record sheds some light on the general questions surrounding movement, but they also lack in the descriptive results that are available with approaches that take directionality into account. While we may get a better idea of at what distances artifacts would typically travel before being discarded, we are not getting a picture of preferred landscapes, environments, and clusters of habitation.

Figure 3.17 Example of hypothetical map of a steep fall-off at 50km intervals.
3.4 Geospatial Methods

The focus of this dissertation is primarily on the results of introducing a GIS interpolation method into the field of archaeology, specifically to the subset of archaeologists attempting to understand mobility at a regional scale. Other methodologies are utilized to understand the directionality of movement as well as provide guidelines on how to interpret the interpolated results. The first approach creates straight line distance maps expressing the intensity and distribution of non-local raw material transit into the Ohio region for each projectile point type. These maps provide more information on the role of non-local raw materials in the projectile point distributions and gives insight into which directions indicate stronger or weaker connections with the borders of the study area. The final directional model utilizes interpolation and focuses specifically on the utilization of Upper Mercer and Flint Ridge Flint across space and time.

3.4.1 Non-Local Raw Materials Maps

The non-local raw material distance maps were generated by taking a tally of where and how many of each of the diagnostic projectile points were constructed of non-local raw materials. A straight line was the mapped, illustrating the link between that projectile point find location and the lithic source from which it was originally procured. The map below provides an example for what we would expect for a group that has strong connections with the non-local region and higher mobility (Figure 3.18).
3.4.2 Interpolation

The interpolation functions described in section 3.2 provide techniques for modeling the distributional patterns of lithic artifacts. Inverse Distance Weighted was used to transform excel spreadsheets containing projectile point information into maps representing lithic supply zones for a series of phases throughout prehistoric time. The interpolation surfaces are related to the fall off curves presented in Figure 3.15, but the interpolation allows direction and landscape to be assessed as well as distance from raw material source. There will be three resulting lithic supply
interpolation layers for each projectile point type. The first section illustrates the distribution of Upper Mercer lithics across the study area for each point type. The second section maps the distribution of Flint Ridge Flint individually. The final surface estimates the distribution of both Upper Mercer and Flint Ridge Flint across the study area. The Upper Mercer and Flint Ridge Flint outcrops are in relatively close proximity to one another. It has been noted several times in the literature that artifacts constructed using each of the two raw materials are commonly found in abundance together. It is not uncommon to have these raw material types dominate the composition of site collections (Seeman 1994; Stothers 1996). Because of this seemingly interchangeable use and the proximity of their outcrops to one another, it was important to also run the interpolation analysis on the raw materials as if they were used interchangeably; both being high quality lithic raw material sources available within a constrained region of the study area. The figure below is an interpolation ran on a hypothetical dataset which presented a 10% raw material density fall-off for every 50km away from the Upper Mercer/Flint Ridge Flint quarry locations, regardless of direction from quarry (Figure 3.19).
Analyzing cultural mobility patterning utilizing archaeological data has followed a variety of pathways in the recent past. With the compilation of large datasets for the Ohio study area, I have been able to both replicate the techniques used by several other archaeologists to understand mobility, as well as construct new methods that present new ways of looking at this type of data. In the majority of previous studies on prehistoric movement, archaeologists have looked at the distributions of lithic raw materials non-directionally. These methods explore general distance trends without immediate regard for patterns that may only be identifiable when looking at datasets using directional methods. I plan to integrate these non-directional analytical techniques in conjunction with new, directionally focused methodologies to better understand the mobility patterns exhibited by the five groups specified for this study area.
Chapter 4: Results

Within this section, I provide general descriptive information regarding the datasets compile for this dissertation. I also include a description of the non-directional Upper Mercer/Flint Ridge Flint fall-off curves for each of the five projectile point styles, and introduce the results for the directional interpolation maps created using the Inverse Distance Weighted function in GIS. Following the Inverse Distance Weighted maps will be a section that illustrates the relative difference between the non-directional methods and the Inverse Distance Weighted method results. I end the chapter by presenting the results of the non-local raw material flow maps.

4.1 General Raw Material Composition

Several non-distance and non-directional patterns pertaining to raw material utilization are presented and are important in documenting Ohio raw material trends in general. The first set of results describe the raw materials used for each diagnostic point type over time (Figure 4.1. It is clear that Upper Mercer and Flint Ridge Flint are two materials that occur in each of the datasets in high quantities. Figure 4.2 represents a comparable graph presenting the proportion of Upper Mercer versus Flint Ridge Flint for each of the projectile point styles. The final compositional graph (Figure 4.3) illustrates details on the raw material types that supplement the Upper Mercer or Flint Ridge Flint percentages within each projectile point dataset.
When the proportion of Upper Mercer versus Flint Ridge flint is evaluated for the four earlier projectile point datasets, we find that Upper Mercer is utilized more frequently (Figure 4.2). Each of the groups consistently are composed of around 75% Upper Mercer and 25% Flint Ridge Flint. On the other hand, Brewerton groups did not focus on the exploitation of Upper Mercer chert of Flint Ridge Flint as heavily as in the previously mentioned periods. In sum Early Paleoindian and Early Archaic raw material choices focusing on Upper Mercer over Flint Ridge Flint are very similar and contrast with the late Middle Archaic pattern.
It is evident that in the study area, Upper Mercer and Flint Ridge Flint dominated each of the study’s point datasets; but there are differences in what types of raw materials supplement other portions of the datasets. In order to facilitate comparison, generally high-quality, non-Ohio materials such as Wyandotte, Onondaga, Paoli, Attica, and Bayport are combined and considered as non-local raw materials and permit a third topic for comparison (Figure 4.3).
Figure 4.3 Percentage of non-local, percentage of Upper Mercer/Flint Ridge Flint, percentage of local raw materials in each projectile point dataset.

More specifically, the Early Paleoindian dataset is composed of about 76% Upper Mercer/Flint Ridge Flint points, 20% non-Ohio, and 4% other local raw materials. Comparatively, Paleoindian mobility allowed for the focused use of high quality resources, but also provided regular access to non-local, high-quality materials from elsewhere in the region. A transition is evident in Figure 4.3 with the increased utilization of local raw materials, and a decrease in the use of non-local materials into the Early Archaic period. The Thebes pattern is characterized by a much greater willingness to utilize other lesser quality Ohio materials at the expense of high quality, non-local sources. The Thebes dataset contains about 60% Upper Mercer/Flint Ridge Flint, 10% non-local, and 30% other local raw materials. The MacCorkle frequencies show a stronger decline in non-Ohio materials and also a decreased use of other local materials. This in turn is followed by an increased use of non-Upper Mercer/Flint Ridge Flint
local Ohio raw materials at the end of the Early Archaic and subsequent Late Archaic periods. MacCorkle is composed of about 88% Upper Mercer/Flint Ridge Flint, 2% non-local raw materials, and 10% other local raw materials. LeCroy groups still maintained a preference for locally available raw materials over non-locals; however the distinct overexploitation of the Upper Mercer and Flint Ridge Flint quarries was on a decline by this time. The LeCroy dataset has about 70% Upper Mercer/Flint Ridge Flint points, 2% non-local, and 28% other local chert types. This acceptance of other locally available raw materials over, in some cases, the more distant Upper Mercer/Flint Ridge Flint outcrops increases into the Brewerton time frame. The Brewerton dataset is comprised of 60% Upper Mercer/Flint Ridge Flint, 2% non-local, and nearly 38% other local raw materials.

4.2 Fall-Off Curves and Concentric Circle Maps

Fall-off curves can provide a basic comparative picture regarding similarities and differences among temporally significant projectile point styles and raw material supply zones. In order to examine these relationships in a spatial framework, these same data can be converted to a series of concentric circles from source centroids.

Figure 4.4 shows the use of Upper Mercer/Flint Ridge Flint by time-specific biface styles over distance. The Clovis/Gainey fall-off curve in the figure above provides a relatively linear fall-off in the percentage of either Upper Mercer/Flint Ridge Flint over distance from the Coshocton County quarries. There is a marked plateau between 150 and 200km, but the fall-off normalizes and maintains a similar slope after the plateau. The fall-off begins around the quarry site, where around 80% of the Early Paleoindian points included were constructed of either Upper Mercer or Flint Ridge Flint. After a linear drop-off over hundreds of kilometers, there are
still small amounts of Upper Mercer and Flint Ridge Flint projectile points in collections at
350km away.

The fall-off curve for Thebes’ points expresses some minor similarities to the fall-off for
Clovis/Gainey. The Thebes composition surrounding the centralized Upper Mercer/Flint Ridge
Flint outcrop location is 83% Upper Mercer/Flint Ridge Flint which is similar to the
Clovis/Gainey pattern. This declines slightly to around 70% at 100km from the outcrops, where
there is a steep sloped fall-off. The patterning for the Thebes fall-off curve is linear, with a much
steeper slope than the fall-off for the Early Paleoindian dataset.

Nearly 100% of all MacCorkle points found at or around the Upper Mercer/Flint Ridge
Flint quarries are constructed of Upper Mercer or Flint Ridge Flint. The fall-off after this
distance is quite distinct in reference to all other point types in the study. The initial drop-off

Figure 4.4 Upper Mercer/Flint Ridge Flint fall-off curves for each projectile point type.
occurs between 100km and 150km, but is slight in nature, and is followed quickly by stabilization until at least 200km from the quarry center.

The LeCroy fall-off curve begins at a much lower density than the MacCorkle fall-off described above, with only about 80% of LeCroy points found surrounding the quarry being constructed of Upper Mercer or Flint Ridge Flint. The fall-off curve for LeCroy begins with a very slight slope, which increases over distance and becomes much steeper as it gets further from the Upper Mercer/Flint Ridge Flint outcrops. The ‘hinge’ where this slope changes most dramatically is around 200km from the outcrop location, where nearly 40% of the points are still identified as either being constructed of Upper Mercer or Flint Ridge Flint.

The fall-off curve for Brewerton points begins with about 80% of the points within 50km of the outcrop center being identified as either Upper Mercer or Flint Ridge Flint. This total drops dramatically at 100km from the quarries, and stabilizes between 150 and 200km, where it is followed by another steep drop-off. This stepped fall-off pattern is reminiscent of the fall-off pattern exhibited by the Early Paleoindian point dataset, but at a consistently lower rate and with a generally steeper slope. In comparison to Figure 29, this rapid drop-off of Upper Mercer and Flint Ridge Flint Brewerton points is because of the increased utilization of other local raw materials.

All patterns but MacCorkle are similar within 50km of the outcrop sources. Where 80% of Clovis/Gainey, Thebes, LeCroy, and Brewerton are constructed of either Upper Mercer or Flint Ridge Flint, over 95% or MacCorkle points found within 50km of the outcrop site are made of either Upper Mercer or Flint Ridge Flint. At 100km from the outcrop source, 80% of Clovis/Gainey and LeCroy are constructed of Upper Mercer/Flint Ridge Flint, while Thebes,
MacCorkle, and Brewerton present at least some fall-off. MacCorkle is still at 83% Upper Mercer/Flint Ridge Flint, while Thebes and Brewerton have around 68% and 70% respectively. By 150km, three styles are in rapid decline regarding the use of Upper Mercer/Flint Ridge Flint and are now below 50% of the raw materials utilized with the exception of MacCorkle and LeCroy. At 200km, all styles have fallen below 50% except for MacCorkle, which is still above 80%. After 200km, data become incomparable, with relatively good data for Clovis/Gainey, but not for the other types. In sum, it would appear that two types of extinction curves are represented. Clovis/Gainey, Thebes, and Brewerton all fall-off dramatically with a distance of 100km of the raw material outcrop to the point that by 150km, they are less than 50% of the raw materials utilized. MacCorkle and LeCroy retain relatively high percentages.

The concentric circle maps provided in Figure 4.5, Figure 4.6, Figure 4.7, Figure 4.8, Figure 4.9 below introduce a notion of space relationships that is not available with the simple fall-off curve graph from Figure 4.4. While the maps are still non-directional in construction, the distance factor is emphasized in the context of the study area. The concentric circle distribution for Early Paleoindian points seems generally much more dispersed in terms of the density and distance that Upper Mercer and Flint Ridge Flint reach throughout the region. A substantial percentage of the other raw materials used to make Clovis/Gainey points across this distribution are non-local, non-Ohio raw materials. With the transition into the Early Archaic period, the pattern for Thebes points is more in disperse nature that begins to centralize and focus around the Upper Mercer and Flint Ridge Flint outcrops. This is followed by the MacCorkle distribution, which is overwhelming dominated by Upper Mercer and Flint Ridge Flint throughout the entire study area. The LeCroy concentric circle map shows a dispersed pattern reminiscent of the Early Paleoindian pattern, with a much more limited reach, but with local, lower quality cherts making
up the majority of the remainder. This is followed, in time, by the Brewerton distribution which shows a constraining and focus around the outcrop locations, which is similar to the Thebes patterning.

Figure 4.5 Early Paleoindian Fall-off Curve Concentric Circle Map
Figure 4.6 Thebes Fall-off Curve Concentric Circle Map

Figure 4.7 MacCorkle Fall-off Curve Concentric Circle Map
Figure 4.8 LeCroy Fall-off Curve Concentric Circle Map

Figure 4.9 Brewerton Fall-off Curve Concentric Circle Map
4.3 Interpolation Surfaces

While the above section presents non-directional comparative results with respect to the lithic supply, this section reviews results that consider both distance and direction within the study area. Whereas a non-directional approach is robust, especially if the concern is only distance, modeling lithic supply zones by constructing directionally sensitive, interpolated surfaces provides a more realistic look at the shape of these areas, and also illustrates the effects of topography and proximity to other resources. To examine these effects, the Inverse Distance Weighted function in ArcMap 10.1 was utilized to create an approximated surface representing the lithic supply zones, and thus mobility ranges, for each archaeological group in this study. The interpolation results are separated into four different subsections. The first is the interpolation of points constructed of only Upper Mercer chert. The second is the estimated distribution of points made of only Flint Ridge Flint. The third is the interpolated surface for points constructed of either Upper Mercer or Flint Ridge Flint, taking the raw material sources as ‘one source’, as they are both of high quality and the outcrops are located relatively close to one another. The final interpolation map for each point type displays the core area of the third interpolation, or regions on the surface with an interpolated value of at least 70% Upper Mercer/Flint Ridge Flint. These interpolation results are presented below in the framework of projectile point type.

4.3.1 Early Paleoindian Interpolation Results

The results for the Early Paleoindian surface interpolations reveal more information about the direction, intensity, and shape of the lithic supply zones than what we have seen in the previously discussed approaches. In this case, we see that both Upper Mercer and Flint Ridge Flint were resources heavily utilized by the colonizing Early Paleoindian groups. The interpolation for Upper Mercer chert alone reveals movement in all directions surrounding the
Upper Mercer outcrop locations (Figure 4.10). There are interruptions in higher quantities of Upper Mercer in the vicinity of Licking County because of the presence of the Flint Ridge Flint outcrops. The distribution of Flint Ridge Flint Early Paleoindian points in the study area mimics the distribution of Upper Mercer points, but at a much more limited density (Figure 4.11).

When Upper Mercer and Flint Ridge Flint are combined due to their proximity, the interpolation surface is relatively dense in all directions (Figure 4.12). The fall-off is more gradual towards the west, and steeper towards the east. The low density of points in the unglaciated plateau of southeast Ohio make difficult any interpretations of exactly what pattern of lithic supply pertains to this area. Figure 4.13 suggests a linear north-south orientation of the supply zone for Upper Mercer and Flint Ridge Flint throughout the study area during the Early Paleoindian timeframe. Upper Mercer and Flint Ridge Flint met their furthest reaches towards the northwestern border of present day Ohio/Michigan, and the south central region of Ohio. The distribution was interrupted in the northeast, possibly due to the influence of Onondaga from the eastern shores of northern Lake Erie; to the east, which was probably affected by limited accessibility due to rugged terrain; and to the west, probably due to the influence and availability of Indiana non-local raw materials.
Figure 4.10 Early Paleoindian Upper Mercer Interpolation.
Figure 4.11 Early Paleoindian Flint Ridge Flint Interpolation.
Figure 4.12 Early Paleoindian Upper Mercer/Flint Ridge Flint Interpolation.
Figure 4.13 Early Paleoindian Upper Mercer/Flint Ridge Flint Core Area Interpolation.
4.3.2 Thebes Interpolation Results

The four interpolation surface figures above for the Early Archaic Thebes projectile points represent a lithic supply distribution for Upper Mercer and Flint Ridge Flint that is distinct in character from the Early Paleoindian distribution mentioned in the previous section. Results for the Upper Mercer interpolation on the Thebes dataset show a clear focus on the eastern portion of the study area. The general distribution seems to be ovate in shape, centering on the availability of access to the Upper Mercer quarry locations (Figure 4.14). The distribution represented by the Flint Ridge Flint interpolation is sparse and sporadic. While Flint Ridge Flint Thebes points were distributed throughout central Ohio counties, they were not prevalent or found in high quantities (Figure 4.15).

The next distribution combines the totals of Upper Mercer and Flint Ridge Flint to develop an interpolated surface, and the differences between Thebes and Early Paleoindian become even more noticeable (Figure 4.16). With the Thebes lithic supply zone, there is a more compressed and localized focus around the quarry locations and throughout the central and eastern borders of modern day Ohio. There is also a more gradual fall-off represented to both the northeast and southwestern portions of the study area. The fall-off in general is more equivalent in all directions than what was shown by the Early Paleoindian distribution, with the exception of to the central eastern border, where the fall off is not clear, as it seems to extend past the reaches of the dataset. The results for the Thebes Core Area map (Figure 4.17) appear to be much different from the results for the Early Paleoindian Core Area map. The Thebes Core Area is again, much more compressed and focused easterly, surrounding the Upper Mercer and Flint Ridge Flint outcrops. The shape is much more ovate, and less linear than the shape of the Early Paleoindian core, and the measured area is about 200km by 200km.
Figure 4.14 Thebes Upper Mercer Interpolation
Figure 4.15 Thebes Flint Ridge Flint Interpolation
Figure 4.17 Thebes Upper Mercer/Flint Ridge Flint Core Area Interpolation
4.3.3 MacCorkle Interpolation Results

The MacCorkle surface distribution interpolations are unique and much different from the distributions of the two point types that were previously discussed. The distribution of Upper Mercer MacCorkle points is relatively dense throughout the surveyed counties (Figure 4.18). There are a few exceptions. There are relatively low quantities of Upper Mercer (when compared to other counties in the study area) in Perry, Ross, and Sandusky County. There is a high density of Upper Mercer MacCorkle points in Coshocton, Knox, Ashland, Wood, and Cuyahoga Counties. The distribution of Flint Ridge Flint points in the case of the MacCorkle interpolation seems to serve as a complement in many ways to the distribution of Upper Mercer chert, and the reaches of Flint Ridge Flint seems to reach further than with the Early Paleoindian and Thebes examples (Figure 4.19). In the counties that lack high numbers of Upper Mercer points, there is a higher use of Flint Ridge Flint. There are higher quantities of Flint Ridge Flint in Perry, Logan, Crawford, and Richland Counties. There are lower densities of Flint Ridge Flint in Coshocton, Knox, Erie, and Mahoning Counties.

The combined Upper Mercer and Flint Ridge Flint interpolation results for MacCorkle points illustrate a very large and dense area of distribution (Figure 4.20). The shape of the distribution mimics the study area, and likely extends beyond the perimeters of the study area’s borders. Directionality, it is difficult to judge, as there is not enough distance within the study area to reveal any differences. The Core Area map for MacCorkle is also difficult to dissect, as there is essentially no difference in shape, direction, or density in all directions (Figure 4.21).
Figure 4.18 MacCorkle Upper Mercer Interpolation
Figure 4.19 MacCorkle Flint Ridge Flint Interpolation
Figure 4.20 MacCorkle Upper Mercer/Flint Ridge Flint Interpolation
Figure 4.21 MacCorkle Upper Mercer/Flint Ridge Flint Core Area Interpolation
4.3.4 LeCroy Interpolation Results

The interpolated surfaces for LeCroy points again, show a transition away from the patterns present in the previously discussed timeframes. The Upper Mercer distribution clearly defines a more northern ovate shape than what was present for Early Paleoindian, Thebes, or MacCorkle points (Figure 4.22). Radiating out from this northern locus, a relatively gradual but prominent fall-off curve is seen in all directions. The distribution seen with the LeCroy Flint Ridge Flint interpolation is generally very light in density, with a few hot spots in areas that are interestingly not only focused around the Licking County outcrops (Figure 4.23).

When the two individual interpolation distributions are combined, there is a distinct easterly focus for the distribution of LeCroy points constructed of either Upper Mercer or Flint Ridge Flint (Figure 4.24). The barrier between heavy utilization and light utilization seems to dissect central Ohio, cutting between the Licking County Flint Ridge outcrops, and the Delaware County Delaware chert outcrops. This heavy utilization also slightly tapers off towards northeastern Ohio. The fall-off curve is relatively gradual towards the west, and the eastern fall-off is not distinguishable, as the distribution extends beyond the study area. The easterly distribution is only made clearer with the LeCroy Core Area map (Figure 4.25).
Figure 4.22 LeCroy Upper Mercer Interpolation
Figure 4.24 LeCroy Upper Mercer/Flint Ridge Flint Interpolation
Figure 4.25 LeCroy Upper Mercer/Flint Ridge Flint Core Area Interpolation
4.3.5 Brewerton Interpolation Results

Interpolations for Brewerton points in some ways reflect similarities to the distributions noted above, but also indicate a much different pattern of mobility from the previous timeframes. As Figure 4.26 and Figure 4.27 indicate, there is a transition in the relative composition of Upper Mercer versus Flint Ridge Flint points that exists into the Brewerton timeframe. In the other point surfaces, Upper Mercer was preferentially utilized over Flint Ridge Flint; however this does not appear to be the case with Brewerton points. The Upper Mercer distribution shows a general light density across space, with a more moderate distribution towards the northeast (Figure 4.26). The Flint Ridge Flint distribution reflects the opposite. There is a light distribution of Flint Ridge Flint across the study area, but the more moderate distributions are connected towards the southwest (Figure 4.27).

The interpolation of Brewerton points constructed of either Upper Mercer or Flint Ridge Flint illustrates a constrained focus on the two central Ohio raw material sources centering on the outcrop locations themselves (Figure 4.28). The Core Area distribution shows linear pattern following along the Muskingum Valley drainage in eastern Ohio; with a somewhat shorter reach to the one presented in the LeCroy Core Area above (Figure 4.29).
Figure 4.26 Brewerton Upper Mercer Interpolation
Figure 4.27 Brewerton Flint Ridge Flint Interpolation
Figure 4.28 Brewerton Upper Mercer/Flint Ridge Flint Interpolation
Figure 4.29 Brewerton Upper Mercer/Flint Ridge Flint Core Area Interpolation
4.4 Comparison of Fall-Off Results and Inverse Distance Weighted (Difference Maps) Results

The results the following section illustrate the calculated difference between the estimated percentages for each projectile point type constructed of Upper Mercer or Flint Ridge Flint using fall-off curves versus the estimated percentages using the Inverse Distance Weighted methodology. The maps were generated by taking the fall-off curve result for individual cells and subtracting from that the Inverse Distance Weighted result. Cells that are blue in color indicate cells where the fall-off curve underestimated the use of Upper Mercer/Flint Ridge Flint points than the fall-off curve. Cells that are red in color indicate locations where the fall-off curve overestimated the use of Upper Mercer/Flint Ridge Flint points.

4.4.1 Clovis/Gainey Difference Map Results

Figure 4.30 presents a new method of comparing the results from the non-directional fall-off curve with the results of the Inverse Distance Weighted method for the Clovis/Gainey distributions. The raster difference maps present an interesting line of support leading to the conclusions that fall-off curves are not enough to illustrate the complexity of the land use patterns for Early Paleoindians.
Figure 4.30 Difference Map (Fall-off curve estimate-IDW estimate) For Clovis/Gaine
4.4.2 Thebes Difference Map Results

The results for the Thebes difference maps present relatively few obvious cases where the fall-off curve estimate was dramatically different from the Inverse Distance Weighted estimate (Figure 4.31). There are two main cases where the difference is more obvious for Thebes points. The first would be the detection of an increased use of Upper Mercer or Flint Ridge Flint in the northwest corner of the study area. The second is the lower use perceived by IDW for Delaware County.
Figure 4.31 Difference Map (Fall-off curve estimate-IDW estimate) For Thebes
4.4.3 MacCorkle Difference Map Results

With the Inverse Distance Weighted estimation results for MacCorkle, we see a nearly ubiquitous distribution of Upper Mercer/Flint Ridge Flint across the surveyed region. This intense distribution was somewhat mirrored in the fall-off curve. The difference map in Figure 4.32 allows the reader to identify two points of connection for the MacCorkle projectile point distribution that is not immediately evident in the fall-off curve maps alone. The first is the weak, but present, connection with the local raw material sources in the northwest, northeast, and southeast portions of the study area. The second addition that Inverse Distance Weighted provides is the detection of the higher percentage of Upper Mercer and Flint Ridge Flint MacCorkle points present in the north, west, and southwest regions of the study area.
Figure 4.32 Difference Map (Fall-off curve estimate-IDW estimate) For MacCorkle
4.4.4 LeCroy Difference Map Results

The difference map for the LeCroy distributions indicates that the differences between the fall-off curve and Inverse Distance Weighted results are relatively minor with one exception (Figure 4.33). The Inverse Distance Weighted distribution provides more information on the impact of the presence of local raw materials on the distribution/density of Upper Mercer/Flint Ridge Flint within the study area. The difference map specifically highlights the impact of local raw materials in the western portion of the region, where IDW was able to show a lower utilization of Upper Mercer/Flint Ridge Flint than would be expected from just viewing the fall-off curve.
Figure 4.33 Difference Map (Fall-off curve estimate-IDW estimate) For LeCroy
4.4.5 Brewerton Difference Map Results

The results from the Brewerton difference map (Figure 4.34) are quite distinctive when being compared with the previously discussed difference maps for Thebes, MacCorkle, and LeCroy in that the differences are more pronounced with the Brewerton distribution than with the early point style distributions. Inverse Distance Weighted clearly highlights the impact of the available local lithic raw materials in the central/western portion of the study area by estimating lower percentages for Upper Mercer/Flint Ridge Flint in the counties to the west of the Upper Mercer/Flint Ridge Flint outcrops. The difference map for Brewerton also provides indicators of a stronger connection to the north, notably the northeast, where estimates for the utilization intensity for Upper Mercer/Flint Ridge Flint is much higher with the Inverse Distance Weighted estimates than what one would predict with the fall-off curves.
Figure 4.34 Difference Map (Fall-off curve estimate-IDW estimate) For Brewerton
4.5 Non-Local Raw Material Maps

It has been established that the relative importance of non-local raw materials in the composition of point collections has declined over time. This final section of the results will be a presentation of the directional data of these non-local raw materials. The Non-local Flow Maps presented in this section represent the flow of previously determined ‘non-local’ raw materials into the study area for each of the five study groups.

The directionality of non-local raw material flow into the study area for the Early Paleoindian time period is presented in the figure below (Figure 4.35). This map shows that the movement into the research area is, to a large extent, controlled by two sources; Onondaga to the northeast, and Wyandotte to the southwest. The reaches of these two raw materials penetrate well into Ohio, and is not limited to the counties most adjacent to the outcrop locations. A secondary pattern presented by the figure above is the moderate importance of the Attica outcrop in northwestern Indiana. Attica chert stretches into both the northern and southern portions of the study area for the Early Paleoindian distribution.
Progressing into the succeeding Early Archaic Thebes phase, there is a somewhat similar distribution to the Early Paleoindian Non-local Flow Map discussed in the section above, although it is notable that the Attica source is targeting a social network that is focused in the north rather than in both the north and the south (Figure 4.36). Bayport is also introduced as a new non-local raw material focusing on distribution throughout northern Ohio.
The MacCorkle Non-local Flow Map (Figure 4.37) indicates a notable connection that is emanating predominately from the southwest. It is also notable that the non-local raw materials are entering the study area in a much more limited quantity during this timeframe.
Figure 4.37 MacCorkle Non-local Flow Map

Figure 4.38 provides more information on the flow of non-local raw materials into the study area throughout the LeCroy timeframe. As compared to the distributions with the Early Paleoindian and Thebes timeframes, a connection to the northeast and to the southwest is once again emerging, but these connects appear to have a relatively low reach in terms of distance, and the non-local raw materials are not penetrating throughout the study area in the same strength as seen with the other timeframes.
Figure 4.38 LeCroy Non-local Flow Map

The Brewerton Non-local Flow Map (Figure 4.39) unveils a transition away from the southwestern connection seen with all previous groups, and a large focus on connecting to resources to the north. The northeastern Ohio to Onondaga source and network is evident along the Lake Erie shoreline. It is important to note that, as with the patterning seen with LeCroy non-local raw materials, the relative reach of a majority of Brewerton points constructed of non-local raw materials is limited to the counties that are most closely located to the non-local raw material sources.
Although these patterns of distribution from source to county of find clearly show distinct distributions, it is important to qualify these findings with the recognition that the total number of points is not equivalent across the study area, or across point types. I have included a measure of average distance of each raw material from source to find location. The data presented in the table below generally support what is evident in the Non-local Flow Maps above (Table 4.1).
Table 4.1 Average KM between Non-local Material Source and Find Location.

<table>
<thead>
<tr>
<th></th>
<th>early PI</th>
<th>Thebes</th>
<th>MacCorkle</th>
<th>LeCroy</th>
<th>Brewerton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onondaga</td>
<td>526 (14pts)</td>
<td>462 (4pts)</td>
<td>410 (1pt)</td>
<td>469 (8pts)</td>
<td>445 (28pts)</td>
</tr>
<tr>
<td>Wyandotte</td>
<td>372 (46pts)</td>
<td>431 (5pts)</td>
<td>377 (5pts)</td>
<td>202 (4pts)</td>
<td>NA</td>
</tr>
<tr>
<td>Attica</td>
<td>347 (9pts)</td>
<td>391 (3pts)</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Bayport</td>
<td>NA</td>
<td>224 (8pts)</td>
<td>NA</td>
<td>235 (1pt)</td>
<td>263 (3pts)</td>
</tr>
<tr>
<td>Paoli</td>
<td>96 (12pts)</td>
<td>230 (1pt)</td>
<td>110 (1pt)</td>
<td>100 (2pts)</td>
<td>NA</td>
</tr>
</tbody>
</table>

The results discussed in this chapter include non-directional/non-distance approaches, distance based approaches, and introduces new methodologies that include analyzing direction and distance relations to unravel space utilization throughout time. Each of these results will be discussed further in the next chapter in terms of how they can be interpreted to understand the changes in mobility throughout time.
Chapter 5: Discussion and Conclusion

The general consensus amongst archaeologists is that mobility ranges for Early Paleoindian groups were larger than for subsequent prehistoric populations. Evidence supporting this notion can be found throughout the archaeological literature and via various methods of analysis. This dissertation provides a systematic, multidisciplinary approach to understanding the change in mobility range throughout prehistoric time by incorporating established methods of understanding with new techniques that incorporate the regional component that is necessary for understanding movement at this scale. Relevant connections between the results of previous published research and the results of this project will be highlighted and presented below. It is important to note that a majority of the discussion within this chapter will focus on connections that can be made with regard to the Early Paleoindian distributions. It is difficult to thoroughly compare the distributions for the Early and late Middle Archaic points to previous research, simply because similar projects have not been published in the past. The table below will be referred to throughout the chapter and includes some of the key results supporting the conclusions of this research (Table 5.1).
### Table 5.1 Results Summary

<table>
<thead>
<tr>
<th>Site</th>
<th>Total Points In Survey</th>
<th>% Upper Mercer/Flint Ridge Flint</th>
<th>% Other Ohio Raw Materials</th>
<th>% Non-Local Raw Materials</th>
<th>General Size of Interpolated Lithic Supply Zone</th>
<th>General Shape of Interpolated Lithic Supply Zone</th>
<th>Intensity of Lithic Supply Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clovis/Gainey</td>
<td>1667</td>
<td>76%</td>
<td>4%</td>
<td>20%</td>
<td>250 km x 250 km</td>
<td>Y</td>
<td>moderate over entire study area</td>
</tr>
<tr>
<td>Thebes</td>
<td>411</td>
<td>60%</td>
<td>31%</td>
<td>9%</td>
<td>200 km x 200 km</td>
<td>O</td>
<td>more intense surrounding quarry, then moderate</td>
</tr>
<tr>
<td>MacCorkle</td>
<td>366</td>
<td>87%</td>
<td>10%</td>
<td>3%</td>
<td>320 km x 320 km</td>
<td>O</td>
<td>high intensity throughout study area</td>
</tr>
<tr>
<td>LeCroy</td>
<td>696</td>
<td>72%</td>
<td>26%</td>
<td>2%</td>
<td>320 km x 240 km</td>
<td>I</td>
<td>more intense surrounding quarry, then moderate</td>
</tr>
<tr>
<td>Brewerton</td>
<td>1685</td>
<td>60%</td>
<td>37%</td>
<td>3%</td>
<td>240 km x 120 km</td>
<td>I</td>
<td>more intense surrounding quarry, then less intense</td>
</tr>
</tbody>
</table>

### 5.1 Methodological Contributions

One of the most important contributions that this dissertation has made to mobility studies in archaeological research is its innovative use of the interpolation functions provided in Geographic Information Systems technology. An intensive evaluation of which interpolation function was better suited for this study was conducted and resulted in the suggested use of Inverse Distance Weighted over Kriging. It is important to note that while Kriging is a preferred
method of interpolation in many studies, it is not preferred in this case because of the impact of the scale at which the data was collected and subsequently mapped. Projectile point data was recorded at the scale of the county rather than individual point find coordinates which are generally not available for archaeological material collected by any means outside of formal excavations.

While interpolation has been conducted infrequently over the past decade at the site scale on archaeological data, I am not aware of any studies (apart from my Master’s thesis) that specifically incorporates the use of interpolation at the regional scale. The use of interpolation allows for a more replicable means of estimating ‘unknown values’ on the lithic supply landscape and reduces the impact of individual bias on the mapping of projectile point lithic supply zone distributions; creating a baseline for making comparisons of changes across time. Interpolation also allows for the visualization of graded fall-offs of lithics from their quarry source which provides more information on how the landscape was utilized and how different large scale landscape characteristics impact mobility patterns. Historically, these ‘fall-offs’ have only been evaluated using non-directional data – simply looking at percentage of a raw material over distance from that raw material’s quarry location. The difference maps referenced in the results chapter (section 4.4) provide a visualization of the difference in fall-off estimation once direction is taken into account. Incorporating the results from the interpolation study along with the methods mentioned in the beginning of this chapter is what allowed for a more comprehensive analysis of mobility changes through time.
5.2 Contributions to Mobility Studies

5.2.1 Clovis and Gainey: Early Paleoindian (11,050 – 10,800 BP)

Kelly and Todd (1988) presented arguments that suggested Early Paleoindians had the largest mobility ranges in prehistoric North America. In the years since their publication, this statement was frequently supported by subsequent authors (Gramly 1988; Seeman 1994; Mullett 2009; Aagesen 2010; Ellis 2011; White 2012). Results in this dissertation support the conclusion that the Early Paleoindian lithic supply zones were indeed large. Using the results from multiple methods of analysis for prehistoric mobility, it is clear that Early Paleoindian group movement was characterized by frequent, far ranging moves. Out of each of the five archaeological diagnostics studied in this dissertation, Early Paleoindian fluted projectile points were most frequently identified as a non-local raw material. When examined even more closely, the non-local raw materials that were used by Early Paleoindians, on average, were deposited farther from their raw material outcrop than non-locals that were used by the subsequent groups in the study. During this timeframe, lower quality local raw materials did not present as intervening opportunities. The non-Upper Mercer/Flint Ridge Flint raw materials were simply not as functional as other high quality raw materials found throughout the study area. This supports the suggestion set forth by the work of Kelly and Todd (1988), Gramly (1988), Seeman (1994), Holen (2001), Mullett (2009), Aagesen (2010), and White (2012) that Early Paleoindians were more likely than later groups to supplement the use of local high quality flints with the frequent utilization of high quality, non-local raw materials from afar. Along these lines, and correlating to the high use of non-local raw materials, there seem to be direct and intense connections with territories at the borders of the study area, including those near the Onondaga quarries in western New York, the Paoli/Carter Cave quarries in northern Kentucky, the Wyandotte quarries in
southern Indiana, and the Attica quarries in western Indiana. Of each of these connections, it seems like the strongest is with the northeast and the southwest; which supports Ellis’s conclusions of a strong North-South connection for Early Paleoindians in Ontario.

While the interpolated 70% or higher percentage of Upper Mercer/Flint Ridge Flint boundary for Early Paleoindians in the Ohio area is not necessarily larger than that of subsequent groups; the decrease from source in the utilization of Upper Mercer and Flint Ridge Flint is more gradual than with the Thebes, LeCroy, and Brewerton groups. One can clearly see the impact of the surrounding state’s high quality raw material sources on the interpolated distribution for the Early Paleoindian Upper Mercer/Flint Ridge Flint lithic supply zone. When reviewing the shape of the Early Paleoindian lithic supply zone for the two raw materials, there is a marked decrease in Upper Mercer/Flint Ridge Flint percentages along the northeastern, southwestern, and western borders of the study area; creating an elongated ‘Y’ shaped distribution. Typically; lithic supply zones are perceived and illustrated as ovate or semi-ovate figures. When referencing the Early Paleoindian interpolation, one will notice that these shapes are not ovate, radiating circularly out from the quarry center. The Early Paleoindian distribution in particular is hugely effected by the non-local raw materials, as was mentioned earlier; in turn making the shape more linear.

The approximate measurement of the longest ‘arms’ of the Upper Mercer/Flint Ridge Flint lithic supply zone for Early Paleoindians comes to around 250km x 250km. While similar to the estimates provided by Ellis (2011) and Mullett (2009), this is a bit smaller than those supply zones estimated by Gramly (1988), Seeman (1994), and Aagesen (2010). It is, unclear what the ‘cut-off’ was for establishing the supply zone borders postulated by these authors. The 70% selected for the representation within this dissertation is certainly fairly ‘strict’; and the supply zone would stretch further had the cut-off been relaxed to either 50% or even 60%. The
second point is that one of the main differences in the lithic supply zone generated by this research versus the lithic supply zones generated in the past is the shape. This study provides the most accurate portrayal of the shape, size, and intensity of Early Paleoindian lithic supply in the Ohio area to date.

In sum, after reviewing the results from multiple lines of analysis; I conclude that the Early Paleoindian mobility range was expansive. In regions throughout the study area where Upper Mercer and Flint Ridge Flint were used less intensively; non-local raw materials from long distances supplemented the assemblages. I argue that stark borders defining the lithic supply zone are not necessarily the only component needed to make statements regarding the mobility strategies for these groups. The gradual fall-off presented in the graded interpolation map (Figure 33) also illustrate the extensive reach of Upper Mercer and Flint Ridge Flint during this time period; while providing more detail regarding the impact of different features on the landscape (e.g. presence of high quality lithic outcrops, presence of mountain ranges).

5.2.2 Thebes: Earliest Early Archaic (10,000-8,000 BP)

Armed with expectations from Caldwell’s Primary Forest Efficiency, one would assume the evidence from this study would point to a slightly reduced mobility range over that of the Early Paleoindian groups for Thebes groups at the very beginning of the Holocene. In support of this concept, the impact of non-local raw materials on the distributions of Thebes points throughout the study area is still quite visible in the interpolated maps, but the percentage is much reduced. Further, there is a clear increase in the reliance on local raw materials that was not present in the Early Paleoindian assemblages. The distributions indicate a transition point where the connection with the outer reaches of the study area seem to become less intensive; and the connection with the local landscape seems to increase in intensity. While I believe this more
intense connection with the local area is a direct result of a change in mobility behavior, it is important to acknowledge that the use of local raw materials were introduced into the assemblages because Thebes points, while still large bifaces, were not quite as delicate in their construction as the Early Paleoindian points, and lower quality raw materials were reliable enough for their construction. The fluting of Early Paleoindian Gainey and Clovis points, in particular, is what created a higher risk of failure. Successful fluting in itself requires a higher quality raw material.

The Thebes interpolation maps also illustrate the impact that terrain and access play on the lithic supply zone for Upper Mercer and Flint Ridge Flint. The Thebes points in the eastern portion of the study area, between the Ohio and Pennsylvania border, are more likely to be constructed of Upper Mercer and Flint Ridge Flint than any other raw material. This is probably the result of the relative accessibility of other raw materials in central and western Ohio. While the interpolated mobility range seems slightly more constrained than that of the interpolation for Early Paleoindian, there are still frequent connections with non-local networks that are evident within the results for the non-local raw material distribution maps and the bar graph that shows the percentage of Upper Mercer/Flint Ridge Flint, local, and non-local raw materials. There also seems to be a newer connection with the northwest, with the incorporation of Bayport flint into assemblages within northwest Ohio. Keep in mind that the Bayport flint did not need to be transported exceptionally long distances in order to find itself in archaeological contexts in Ohio.

There is a heavily increased, new utilization of lower quality Ohio raw materials present in Thebes distributions, such as Delaware, Pipe Creek, Plum Run, and 10-Mile, that is not present in Early Paleoindian distributions. This indicates that while still loosely connected to larger
networks outside of the Ohio region, the Thebes groups were becoming more connected to space within the modern day boundaries that compose Ohio.

The shape of the Upper Mercer/Flint Ridge Flint lithic supply zone for Thebes projectile points is much more ovate than the distribution reviewed for Early Paleoindians. The size of the interpolation where 70% or more of the surveyed projectile points were either Upper Mercer or Flint Ridge Flint measures to around 200km x 200km. The results provided to this point seem to be following the notion of a gradual fall off in mobility range over time, as per Caldwell’s previously mentioned Primary Forest Efficiency model.

5.2.3 MacCorkle: Later Early Archaic (9,500-8,000 BP)

When we move into the distributions that are provided for MacCorkle points within Ohio, the smooth transition to smaller territories with the Holocene posited by Caldwell is challenged. Eighty-seven percent of MacCorkle points surveyed from the study area were constructed of either Upper Mercer or Flint Ridge Flint. Of those points; a dominant majority were constructed of a single source, Upper Mercer Flint. Flint Ridge supplements the Upper Mercer distributions in areas where there were fewer Upper Mercer points found; if an assemblage had a low proportion of MacCorkle points made of Upper Mercer, there is a high percentage of Flint Ridge Flint points. The measured lithic supply zone for Upper Mercer/Flint Ridge Flint MacCorkle points is around 320km x 320km; which is the largest possible interpolated border. The shape is a rectangle, which was generated artificially through the process of interpolation.

There is a weaker connection to the region at the borders of the project’s study area, evidenced by a general lack of utilization of non-local raw materials found outside of the borders of modern day Ohio. In short, there was a very different raw material acquisition behavior
occurring during this time period than previously. There may have been an influx of a different population into the region, perhaps an extension to the southern expansion of the Kirk tradition. I would also suggest that the general ‘all or nothing’ distribution of Upper Mercer/Flint Ridge Flint MacCorkle points in the area would suggest that there is a heightened territoriality that is experienced during this time. It is interesting to compare the maps for the MacCorkle distributions with the maps provided by Anderson and Hanson (1988), the suggested patterns described by Stafford (1994) and then again to the maps provided by Daniel (2001). The mobility ranges posited by Anderson and Hanson (1988) and Stafford (1994) suggest a heavy correlation between mobility range borders and the distribution of main. The ranges suggested by Anderson and Hanson are around 50km wide, by nearly 400 km long. Later Daniel (2001), in a similar study, drew the borders of the mobility ranges for the same groups as Anderson and Hanson as large, ovate shapes with centers around two main lithic quarry sources. While my data was not able to be collected at a fine enough scale to immediately map the distributions in comparison to the main waterways, the ubiquitous presence of Upper Mercer or Flint Ridge Flint throughout the study area for MacCorkle points would suggest little correlation with any particular drainage basin. On the other hand, there seems to be more support for Daniel’s model that centers mobility range on a single high quality lithic outcrop. On this note, it would be interesting to compare the lithic sources and subsequent supply zone distributions for MacCorkle points in neighboring regions to determine if the intensive utilization of a single raw material during this timeframe is consistent across multiple environments, or if the Ohio for MacCorkle is unique.
5.2.4 LeCroy: Latest Early Archaic (8,500-7,800BP)

As the middle of the Holocene is approached, we transition into the LeCroy phase for the Ohio region. There is a clear relaxing of the abundant use of Upper Mercer and Flint Ridge Flint that was present during the MacCorkle phase. There is an increased utilization of local raw materials that effects the distribution of the lithic supply zone for LeCroy points. In this phase, the lithic supply zone is measured at 320km x 240km, with more constraints to the supply zone to the east and west. The distribution is now constrained by the supplemental use of local raw materials as opposed to nonlocals, which is contrary to the results seen with the Thebes and Early Paleoindian phases. The lower quality, local raw materials became intervening opportunities during this time because subsistence changed and settlement on the landscape allowed for more exposure to the lithic source sites. This is an indicator that the LeCroy point using populations were settling and again becoming more connected with the local resources and invested in the Ohio region. It is also important to acknowledge that this increased use of local raw materials could also be, in part, a result of the change in technological design between MacCorkle points and LeCroy points. While still finely made, LeCroy points are inherently very small and delicate, while the previously discussed Clovis, Thebes, and MacCorkle points are quite large, generally requiring the availability of a large biface. As a result, LeCroy points can be constructed out of relatively small sized lithics, including flakes.

The LeCroy distribution presents interesting points in transition that follow along with the trajectory suggested by Caldwell. While the measured supply range for Upper Mercer and Flint Ridge Flint seems larger than that of Thebes or even Early Paleoindian, it is important to note the general lack of use of non-local raw material and the new-found frequent integration of local raw materials in the construction of LeCroy points. There is a dramatic increase in the total
number of LeCroy points over that of the survey totals for Thebes or MacCorkle. Without treading too close to correlating simple totals of points with population size; the increased number of LeCroy projectile points found within the region should be noted as an indicator of population and mobility strategy change.

5.2.5 Brewerton: Early Late Archaic (5,000-4,000 BP)

Finally, the distribution of the latest points on our timeline, the early late Archaic Brewerton points, has several qualities that imply a further settling in and more refined connection to the resources of the Ohio region. Of these diagnostic point examples, Brewerton points are the most likely to be constructed of local raw materials. For example, the average Paleoindian point constructed of Onondaga flint was found over 525km away; whereas the average Brewerton point constructed of Onondaga flint was found only 445km away. The connection with the Onondaga quarry seems to be highest with Northeast Ohio in the case of Brewerton points. While there are connections with ‘non-local’ raw materials, the transport tends to be much more abbreviated in space. Once again, this increased reliance (and ability for a reliance) on local raw materials could be encouraged by the transition in technology to a small, less refined projectile point type than those discussed before.

The interpolated distribution of the Upper Mercer/Flint Ridge Flint lithic supply zone for Brewerton points is linear in shape, with a north to south trend. The measurements for the supply zone are around 120km to the east-west by 240 km to the north-south. The impact of local raw material availability can be seen in the distribution of Upper Mercer/Flint Ridge Flint Brewerton points to the east and west – which are more typically constructed of either Delaware in the west or Plum Run in the east.
It is clear that Brewerton points are abundant in the archaeological record. In this survey alone, there were 1,685 analyzed. This could either be the result of the increased utilization of a lower quality/shorter use-life projectile point, the result of population grown; or some combination of the two. While Anderson and Hanson (1988) referred to the Middle Archaic transition in South Carolina, the following quote applies for the Brewerton phase within the study area of this dissertation. Anderson and Hanson (p. 271) suggest that “the most exclusive use of local raw materials characteristic of Middle Archaic groups in the South Atlantic area may reflect increased regional population densities and corresponding decrease in annual range”.

Table 5.2 contains the raw counts of projectile point types that were found by individual collectors within a constrained geographic region. The Harness collection consists of projectile points from the Ross County region of Ohio, the Snyder collection consists of points from the northwestern region of Ohio, and the Mahoning Valley collection consists of points from Mahoning County, Ohio. There is a dramatic increase in the number of points as we move through time from the Early Paleoindian period to the late Archaic period. Nearly half of all points in this three-collection dataset are Brewerton points.
Table 5.2 Diagnostic Projectile Point Totals for Large Collections

<table>
<thead>
<tr>
<th></th>
<th>Harness Collection</th>
<th>Snyder Collection</th>
<th>Mahoning Valley Historical Society Collection</th>
<th>Total From 3 Collections</th>
<th>% From 3 Collections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Paleolithic</td>
<td>6</td>
<td>0</td>
<td>3</td>
<td>9</td>
<td>2%</td>
</tr>
<tr>
<td>Thebes</td>
<td>19</td>
<td>27</td>
<td>5</td>
<td>51</td>
<td>12%</td>
</tr>
<tr>
<td>MacCorkle</td>
<td>4</td>
<td>32</td>
<td>18</td>
<td>54</td>
<td>13%</td>
</tr>
<tr>
<td>LeCroy</td>
<td>27</td>
<td>30</td>
<td>57</td>
<td>114</td>
<td>27%</td>
</tr>
<tr>
<td>Brewerton</td>
<td>62</td>
<td>25</td>
<td>102</td>
<td>189</td>
<td>45%</td>
</tr>
<tr>
<td></td>
<td>118</td>
<td>114</td>
<td>185</td>
<td>417</td>
<td></td>
</tr>
</tbody>
</table>

5.3 Conclusions and Future Work

The research completed in this dissertation addresses one of the most common issues in North American archaeology: mobility and lithic supply. Caldwell’s Primary Forest Efficiency model has been, in one form or another, the basis for understanding mobility and lithic supply throughout time. The results of this dissertation challenge Caldwell’s model. This was a longitudinal study of long term adaptations in the mobility behaviors over a 7,000 year time frame. While lithic supply zone studies may not be a perfect representation of mobility; they are the one measurement that can be constructed throughout time for groups exploiting lithic raw materials. As mentioned throughout the dissertation, lithic supply zones are generally acknowledged within the field of archaeology as comparable to the size of mobility. In general terms, an increase in the stability of the environment resulted in the ability for humans to adapt
and become more successful at exploiting particular patches of predictable subsistence resources. This concept is certainly in line with the Primary Forest Efficiency model. While the long term change within the region fits Caldwell’s model, the decrease in mobility is not represented by a simple and uninterrupted pattern in the archaeological record for the groups that were examined in this research. Rather, the change over time is gradual, but punctuated with early episodes of unexpected lithic utilization patterns.

It seems evident in the results from this research that Early Paleoindian groups did indeed have extremely high mobility. The high proportion of non-local raw materials during this time indicates a strong connection to the landscape at the far edges of the study area. These connections seem to loosen slightly once in the Early Archaic period. For Thebes point using groups, there is still a moderate utilization of non-local raw materials, but an introduction of stronger connections to the local landscape is clearly demonstrated by a marked increase in the use of local raw materials. Slightly later, there seems to be an entirely different occupation and land use behavior during the MacCorkle phase. Nearly all MacCorkle points identified within the dataset in the Ohio region are constructed of Upper Mercer or to a lesser extent Flint Ridge Flint. This is likely connected to the behaviors associated with the Kirk-type distributions mapped by Daniel. MacCorkle distributions seem to be centered on the Upper Mercer/Flint Ridge Flint quarry sites, radiating out with little to no fall off over space. Future research could be conducted on this point type alone to determine the patterns exhibited in surround areas (e.g. Indiana). In this case, point distributions dominated by a single high quality raw material (e.g. Wyandotte) that imply distinctive territories surrounding the high quality raw material outcrops would be expected. The fall-off from the MacCorkle phase through the LeCroy phase and into the Brewerton phase is more in line what the gradual fall-off suggested by Caldwell’s Primary Forest
Efficiency model. There is a true connection with the local landscape that is illustrated by the more intensive use of local raw materials.

Interestingly, in raw quantity totals of points surveyed, there were significantly more LeCroy and Brewerton points found in this research than MacCorkle and Thebes. This was not the result of a lack of effort in finding the Early Archaic point types, but is likely the result of two factors: an increase in population density across the study area and an adjustment in the projectile point technology itself. The smaller size of LeCroy and Brewerton points require relatively small amounts of flint/chert for construction, while the earlier points, which are larger, require more sizable pieces of flint/chert. The size of LeCroy and Brewerton also leaves very little material to resharpen, which creates a shorter use-life. Both of these factors, an increase in population and the shorter lived use life of the later point styles, results in the need to generate larger quantities of points to sustain the population’s subsistence behaviors.

The importance of collaboration in order to gain access to archaeological collections is also highlighted by this research. The Early Paleoindian database was largely composed of projectile points that have been recorded by archaeologists in previous publications, but a comparable database for Archaic points was non-existent and was created in the process of this research in collaboration with Dr. Mark Seeman, various connections to museum and university collections, and through networks of collectors within the Ohio region.

I believe that the field of archaeology would benefit for future work based on the methodologies and continued research presented with this dissertation. It would be a valuable exercise to create a partnership between statisticians, GIS experts, and archaeologists to attempt to develop an interpolation method specifically considering the variables impacting prehistoric
mobility. For the time being, the multi-method approach used in this dissertation could be replicated for many study areas across North America, which would create an important documentation of regional mobility strategies. It is also a goal to continue to add projectile points to my current datasets; replicating the analysis as the sample size grows.

This project contributes to both the field of archaeology and to geography by taking modern geographic methods and techniques and applying them to datasets that are not typically analyzed at the regional scale. Through the process of understanding the changes in mobility throughout prehistoric times, the results highlight the concept that factors impacting human migration remain similar throughout time; subsistence strategy, social connectivity, and the availability of necessary resources. “Populations are on the move in a continuing effort to reach the peaks of an ever-changing opportunity surface” (Alber, Adams, and Gould 1971, 196). The connections of places on this opportunity surface are a direct result of the concepts impacting spatial interaction; including the degree of complementarity, intervening opportunity, and transferability between geographic locations. The result of this dissertation provides perspective on and suggests conclusions supporting a generally accepted; but rarely ‘evaluated’ model for longitudinal change in the mobility structure during the earliest exploitation of the Great Lakes region of North America.
References


