ABSTRACT

Title of Thesis:	REVISITING CHERT PREFERENCES AND LITHIC SUPPLY ZONES OF EARLY ARCHAIC NORTHWESTERN OHIO: A LEAST COST PATH ANALYSIS
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Newly documented lithic data resulting from reconnaissance-level cultural resource management surveys recently conducted in Erie and Huron Counties, Ohio raised questions regarding northwestern Ohio's existing model of Early Archaic chert preferences and lithic supply zones. An initial examination of the artifact assemblages revealed a scarcity of non-local Upper Mercer chert which opposed the current premise on Early Archaic chert utilization and population movements in Ohio. This study attempts to understand the implications of the scarcity of Upper Mercer chert in these northwestern Ohio Early Archaic artifact assemblages by synthesizing regional data and conducting Least Cost Path analyses with Geographic Information System software.

REVISITING CHERT PREFERENCES AND LITHIC SUPPLY ZONES OF EARLY ARCHAIC NORTHWESTERN OHIO: A LEAST COST PATH ANALYSIS

by

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Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

The Early Archaic Period (Early Archaic) in Ohio began 10,000 years ago. During this time, the indigenous peoples inhabiting the region formed nomadic hunter-gatherer bands that traversed long distances to hunt migratory animals and exploit seasonally abundant natural resources (Purtill 2009). The cultural materials left behind by these peoples create archaeological sites from which researchers can extract information about past lifeways. While Early Archaic archaeological sites are abundant in northwestern Ohio, questions remain regarding how Archaic peoples lived within the landscape. Recent archaeological investigations within this region have provided data that has the potential to answer one of these questions.

How do changes in lithic supply zones and preferences for local and non-local lithic material relate to the migrations of Early Archaic people in northwestern Ohio? Data resulting from nine Phase I reconnaissance-level archaeological surveys conducted by archaeologists from The Mannik & Smith Group, Inc. (MSG) in Erie and Huron Counties, Ohio can provide insight to this question. These surveys, which began in the winter of 2018 and ended in the Spring of 2023, were completed as part of the Ohio Power Siting Board permit application process for the creation of wind energy facilities. During these investigations, 378 archaeological sites were identified, including five Pipe Creek chert quarries with Early Archaic components. An initial examination of the artifact assemblages revealed a scarcity of Upper Mercer chert. This observation was intriguing because it opposed the current premise on Early Archaic chert utilization in Ohio: that the majority of tools manufactured during this period were made from Upper Mercer chert from central Ohio. This premise also considers the presence of Upper Mercer chert in northwestern Ohio to be evidence for a southern-derived colonization event (Stothers 1996). This interpretation of chert utilization plays a significant role in our current understanding of Early Archaic population movements in Ohio. This study was undertaken in an attempt to better understand the implications of the scarcity of Upper Mercer chert in northwestern Ohio Early Archaic artifact assemblages.

Three corollary questions are posed to explore specific aspects of this research question:

1) How did chert preferences differ throughout the three Early Archaic horizons in northwestern Ohio?

2) What were the Least Cost Path (LCP) extents of Early Archaic lithic supply zones in northwestern Ohio?

3) Will an analysis of new and existing regional projectile point data support the existing theory of Early Archaic population movements in northwestern Ohio?

Previous archaeological studies have established that sourcing the location of lithic material can infer the movement of people across a landscape (Andrefsky 2008; Dowd 2013; Elston 2013; Goodyear 1979; Gramly 1988; Lepper et al. 2001; Mullet 2009; Seeman 1994; Sparks 2013). Therefore, to answer these questions, a detailed chert-sourcing analysis was conducted on the Early Archaic tools recovered from the five Pipe Creek quarry sites identified by MSG. The results of this analysis were integrated with additional data from other regional lithic procurement studies for a comprehensive understanding of chert utilization preferences in northwestern Ohio. Then, Least Cost Path (LCP) analyses between archaeological site locations and chert outcrop locations were conducted using ESRI's Geographic Information Systems (GIS) Pro software. The resulting least cost paths, equated to lithic supply zones, were then compared with Stothers' (1996) previously suggested lithic supply zones to discern any oppositions between the two datasets.

Changes in preference for local and non-local chert and lithic supply zones extents between the three Early Archaic horizons were observed as a result of these analyses. Connections between chert outcroppings were detected and the extent of previously suggested lithic supply zones for

Pipe Creek and Delaware cherts were expanded. The LCP analysis results were used to propose broad lithic procurement travel routes between central and northwestern Ohio. Consequently, an argument was made regarding the plausibility of Stothers' (1996) colonization hypothesis.

A review of the current knowledge of Early Archaic northwestern Ohio was essential to interpreting the results of the analyses. Chapter 2 of this thesis provides information on the environmental setting, subsistence strategies, demographics, cultural material chronology, and chert-types of the region. Chapter 3 presents an overview of the current state of research, an overview of lithic raw material procurement studies, and examples of successful LCP studies. The methodologies employed by this study, including artifact analysis, regional data aggregation, and LCP analysis are discussed in Chapter 4. The results of this study are presented in Chapter 5, while the analysis of those results is presented in Chapter 6. The final chapter will conclude the thesis and suggest topics for future research.

Chapter 2: Regional Context

Familiarity with the environmental setting of a region and the available chert materials within it is necessary for conducting lithic procurement and mobility studies. Accordingly, this chapter will provide an overview on the paleoenvironment, cultural material chronologies, and chert sources of Early Archaic northwestern Ohio.

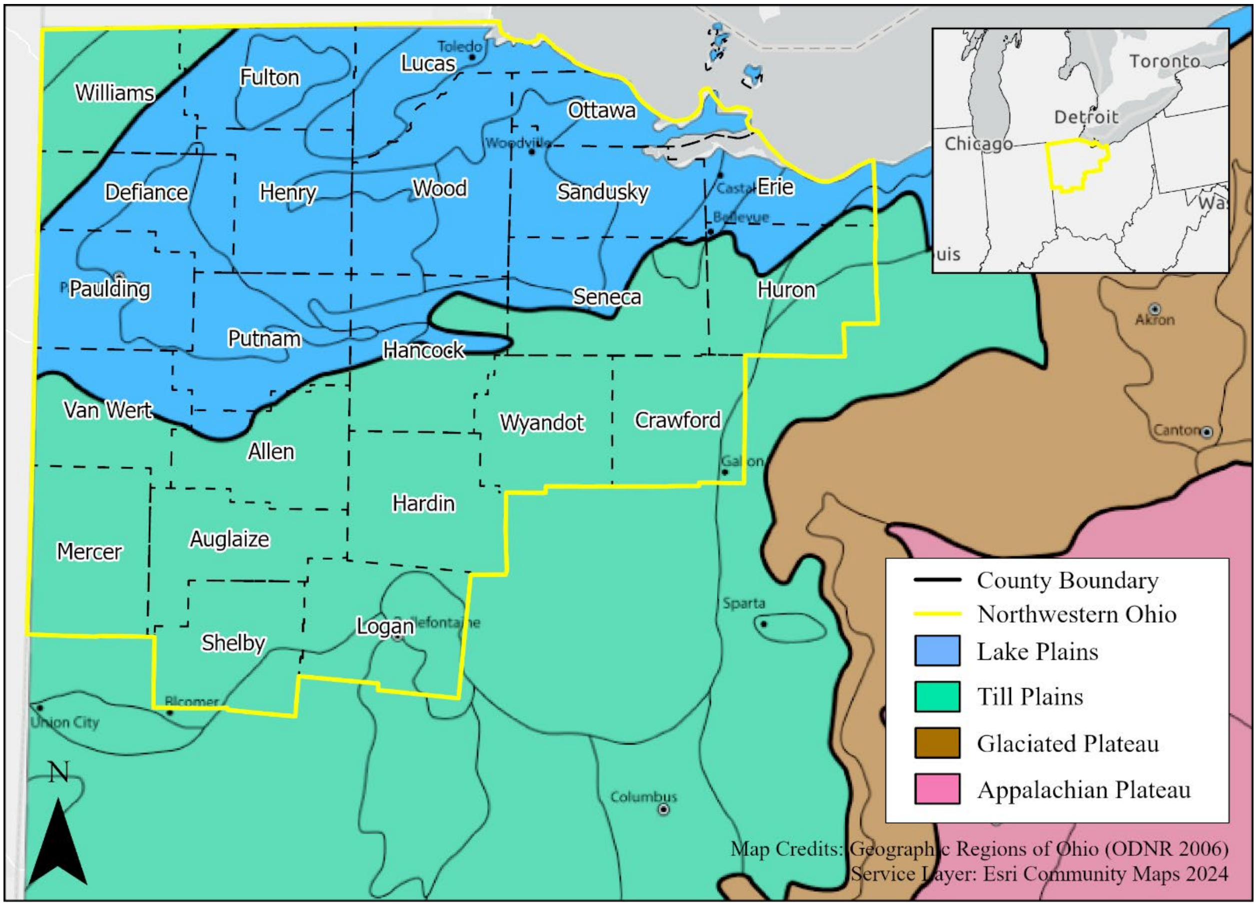
2.1 The Early Archaic Environment of Northwestern Ohio

The Early Archaic of Ohio (10,000 – 8,000 B.P.) was a period of major ecological change. The Hypsithermal interval, which occurred between 9,000 and 6,000 B.P., created a warmer environment than the preceding Paleoindian Period (the terminal Ice Age). This change in climate caused Ohio's coniferous forest to transform into a deciduous forest, the extinction of large Pleistocene mammals, and water level fluctuations across the state (Purtill 2009). The environment of Northwestern Ohio, which borders Western Lake Erie, was especially affected by the changes in the lake's water levels. The following section describes the unique environmental setting of this region during this period and how these environmental changes likely affected the subsistence strategies and demographics of Early Archaic populations.

2.1.1 Setting

Northwestern Ohio spans across two physiographic regions: the Lake and Till Plains (Figure 1). These regions border Lake Erie and are both characterized by the effects of glacial scarring. The Lake Plains Region is a low-elevation flatland that includes relict lake beds and beach ridges. This region experienced fluctuations in water levels throughout the Early Archaic. Lake Erie was estimated to have been 30-40 meters (98-131 feet) below the present lake level during this time, which caused the western basin to become mostly dry. The basin was shallow enough that a mass of land connected northern Ohio to southern Ontario (Forsyth 1973; Holcombe 2003). The Till Plains Region, which is also relatively flat due to glacial retreat, has a wider range of topographic elevations and experienced less water level fluctuations during this period.

Figure 1: Map of Northwest Ohio (map by the author)



2.1.2 Subsistence Strategies

Early Archaic bands relied on a hunting and gathering subsistence strategy which focused on tracking migratory mammals throughout their seasonal movements. These bands initially hunted caribou (*Rangifer tarandus*) and other large Pleistocene mammals but, with the extinction of megafauna species, eventually began to focus on deer

(*Odocoileus virginianus*) and elk (*Cervus elaphus canadensis*). High group mobility allowed for the exploitation of various ecological zones within the region. The groups were able to supplement their hunter-gatherer diet with aquatic resources from Lake Erie in addition to small mammals and wild plant foods—especially tree mast foods— from inland forests. These mixed deciduous forests were largely comprised of oak, hickory, and walnut species (Blank 1970; Pratt 1981; Shane 1994; Stothers 1996).

2.1.3 Demographics

The peoples of the Early Archaic experienced demographic growth, intrastate population movement, and shifts in settlement strategies as a result of the warming climate (Blank 1970, Purtill 2009). Investigations within the region provided evidence that these bands practiced a seasonal settlement system and preferred upland locales for habitation (Abel 1994; Keener et al. 2008). Early Archaic bands are estimated to have varied between 15 and 50 (average 25) persons. This is considered the optimal size for stable organization, gathering resources, and defense. Regional aggregates estimate that 200 to 800 (average 500) persons would form for marriage exchange and reproduction. Some archaeologists believe these intermarriage alliances may have been a catalyst for early interaction and trade networks (Pratt 1981; Stothers et al. 2001).

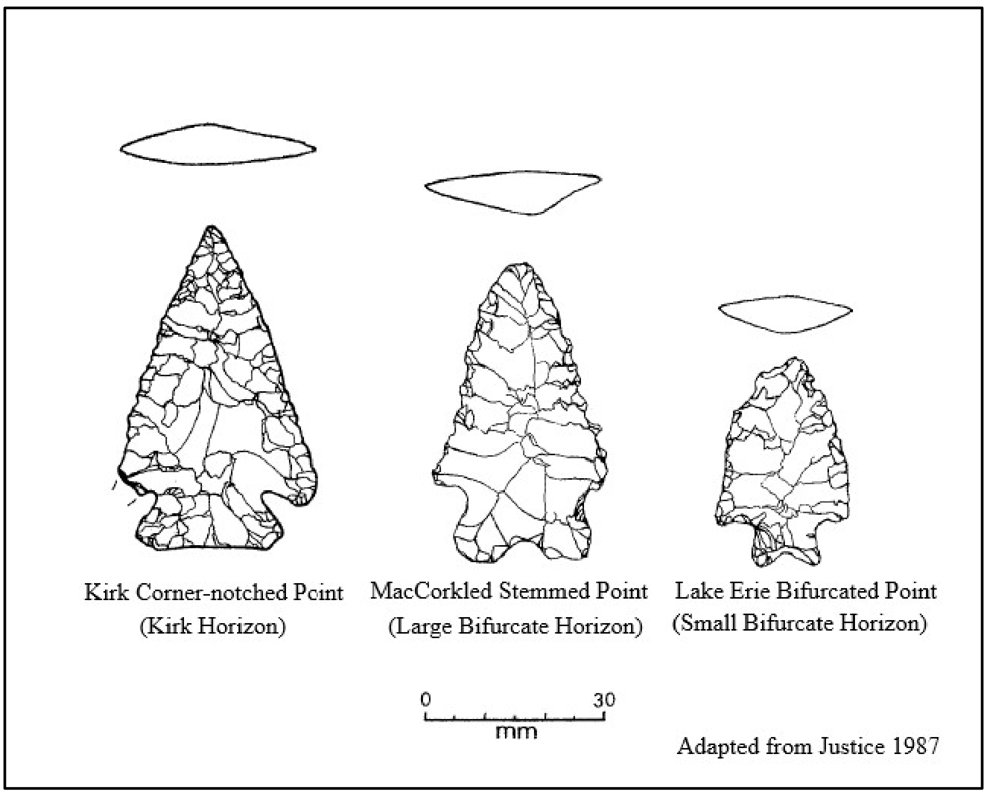
2.2 Projectile Point Horizons of Early Archaic Ohio

The environmental changes of the Early Archaic also led to transformations in cultural materials. The appearance of medium-to-large side- and corner-notched projectile points,[1] which

[1] A projectile point is a hafted chipped-stone tool, typically made from chert, made to be thrown or otherwise projected (such as spearhead, arrowhead, or dart).

marks the beginning of the period, is thought to be a technological adaptation to the hunting of Holocene mammals (Purtill 2009). The three distinct styles of notched projectile points define the three horizons within the Early Archaic. The projectile point horizons investigated in this study include Kirk (Kirk Corner-notched, Palmer Corner-notched, Nettling, and Decatur types; ca. 9,500 to 8,900 B.P.); Large Bifurcate (MacCorkle Stemmed and St. Albans Side-notched types; ca. 9,000 to 8,500 B.P.); and Small Bifurcate types (Lake Erie Bifurcated Base; ca. 8,500 to 7,800 B.P.) (Bowen 1990, 1991; Justice 1987; Purtill 2009) (Figure 2). Some archaeologists view the distinct tool forms of this period as representing separate cultural manifestations or ethnic groups; however, others believe the distinct forms reflect a difference in function. For instance, Kirk Corner-notched points are thought to have functioned as atlatl dart tips while use-wear analyses show that MacCorkle points may have functioned as both projectile and knife (Pratt 1981; Purtill 2009; Stothers et al. 2001).

Figure 2: Early Archaic Projectile Points (adapted from Justice 1987)



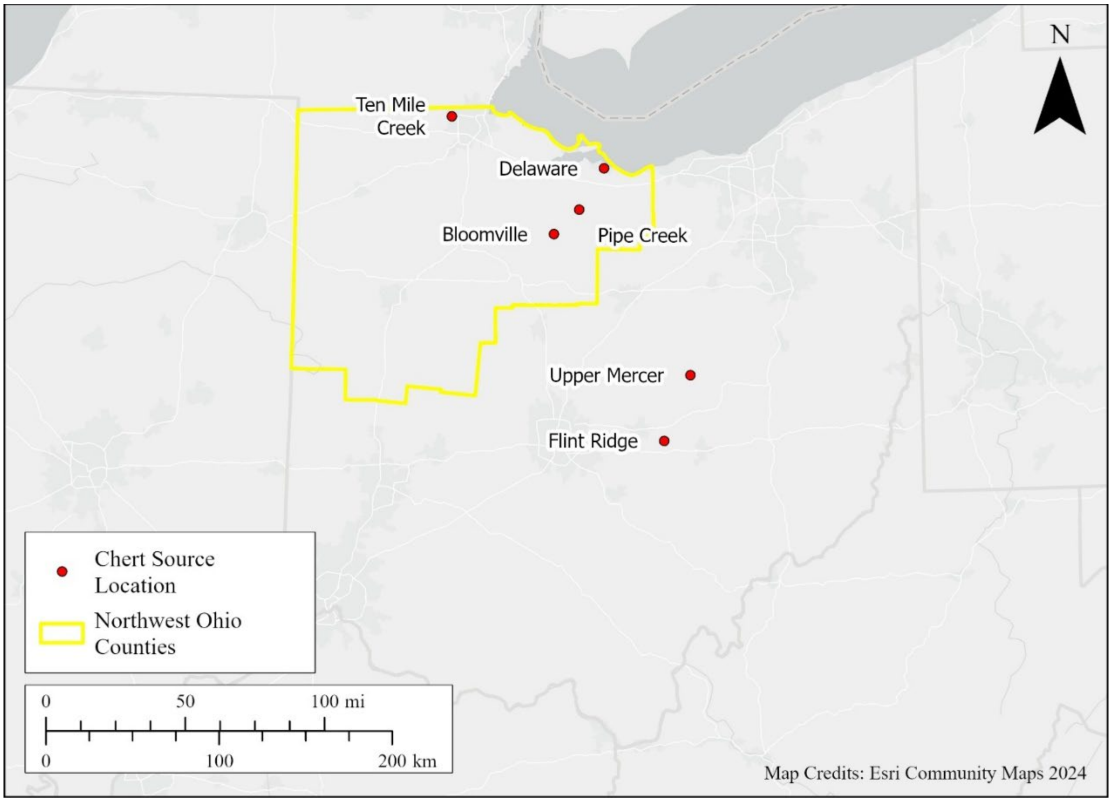
2.3 Chert Types Discussed in this Study

Chert, the most common lithic material used for projectile points, has been defined as all cryptocystalline silicates having genesis from a sedimentary parent material (Andrefsky 2009; Luedtke 1992). While all cherts contain silica, not all cherts are of the same quality. Chert quality is determined by the amount of silica it has, or how vitrified or glass-like the material is. The vitrification of chert contributes to its strength, sharpness, and predictability in breaking pattern. High-quality chert has been historically sought after by stone-tool making cultures, who are often willing to travel long distances or to trade high-value items to acquire specific chert types.

The chemical composition, physical appearance, and overall quality of a chert type is dependent on its geological origin. Therefore, the examination of these characteristics aid in identifying the geographic location of a chert source (see Chapter 4 for further detail on identification methods). Determining the geographic location of a chert type can provide insight to a group's preference for local or non-local chert materials (see Chapter 3 for further detail on lithic raw material procurement theory).

A variety of chert types has been identified in Ohio (DeRegnaucourt and Georgiady 1998; Kagelmacher 2000; Stout and Schoenlaub 1945). The quality, source location, and physical appearance of the six chert types included in this study will be described in detail. In regards to northwestern Ohio, Bloomville, Delaware, Pipe Creek, and Ten Mile Creek are considered local cherts. Upper Mercer and Flint Ridge, which outcrop in central Ohio, are considered to be non-local cherts (Figure 3). DeRegnaucourt and Georgiady (1998), Kagelmacher (2000), and Stout and Schoenlaub (1945) were consulted for all of the following chert descriptions with the addition of other sources for certain cherts. These sources are listed after their relative chert descriptions.

Figure 3: Chert Source Locations (map by the author)



2.3.1 Bloomville

Bloomville chert (identified by Kagelmacher as a Delaware variant) is a chalky to semi-porcelaneous fair-quality chert that outcrops near Honey Creek stream in Seneca County, Ohio (Figure 4). This material occurs as bedded layers in the Delaware Formation Limestone of the Middle Devonian System. This chert ranges in appearance from white to light-gray to light-brown and shares visual similarities with Cedarville-Guelph chert of west-central Ohio. Because of its poor-to-fair quality, archaeologists believe that it was mostly used as locally expedient chert when other materials were hard to obtain.

Figure 4: Bloomville Chert (33ER0675, Object 1156.01) original photo in possession of the author.

2.3.2 Delaware

Delaware is an earthy to porcelaneous fair-to-good quality chert. It occurs as both nodules or bedded layers in the Delaware Formation Limestone of the Muscatatuck Group, Erian Series, Devonian System (Figure 5). The Delaware Formation runs from south-central to north-central Ohio (Delaware and Franklin Counties to Sandusky and Erie Counties). The variant that outcrops in Erie County ranges in appearance from light creams to dark browns and shares visual similarities with some variations of Pipe Creek chert. Delaware is currently thought to be a fairly localized material, only having been documented within a 50 to 65-kilometer (km) (30 to 40-mile [mi]) radius of its primary outcrops.

Figure 5: Delaware Chert (33ER0675, Object 1164.01) original photo in possession of the author.

2.3.3 Pipe Creek

Pipe Creek chert (sometimes referred to as Plum Brook or Prout) is a semi-porcelaneous to waxy high-quality chert that outcrops in Erie and Huron Counties, Ohio (Figure 6). This material occurs as tabular chunks in the Prout Limestone Member of the Niagaran Series of the Devonian System. It outcrops as fossil reef domes in farm fields in north-central Ohio. This chert occurs in many colors including light tans, browns, brownish-reds, and bluish-blacks. The chert was first documented by archaeologists David Stothers and William Rutter who were informed of its location by local avocational

Figure 6: Pipe Creek Chert (33HU0036, Object 3052.01) original photo in possession of the author.

archaeologists in 1976. Before its documentation, it is possible the chert had been mistaken for similar-looking variations of Delaware, Flint Ridge, and Upper Mercer cherts. Kettle Point chert of Ontario, a geological correlate to Pipe Creek, is also visually similar. Pipe Creek is currently thought to be a fairly localized material, only having been documented within a 50-km (30-mi) radius of its primary outcrops (Stothers and Rutter 1978).

2.3.4 Ten Mile Creek

Ten Mile Creek chert is a chalky poor to fair-quality chert that outcrops along Ten Mile Creek in Lucas County, Ohio (Figure 7). This material occurs in bedded layers in the Traverse Formation Limestone of the Middle Devonian System. This chert is typically white to light-gray in color. Because of its poor-to-fair quality, archaeologists believe that it was mostly used as locally expedient chert when other materials were hard to obtain.

Figure 7: Ten Mile Creek Chert (33LU0759), photo used with permission from Robert Chidester.

2.3.5 Flint Ridge

Flint Ridge chert (sometimes referred to as Vanport) is a high-quality porcelaneous chert that outcrops in Licking County, Ohio (Figure 8). This material occurs as tabular chunks in the Vanport Limestone Member of the Allegheny Group of the Pennsylvanian System. This chert occurs in almost every color and can sometimes be translucent. Because of its quality and beauty, it was intensively quarried

Figure 8: Flint Ridge Chert (33HU0047, Object 2873.01) original photo in possession of the author.

and extensively traded to neighboring states throughout all of prehistory (Prufer and Long 1986).

2.3.6 Upper Mercer

Upper Mercer chert is a waxy to porcelaneous high-quality chert that outcrops in Muskingum, Coshocoton, Licking, Perry, and Hocking Counties, Ohio (Figure 9). This material can be found in blocks bedded within limestone and can erode out into streams as tabular chunks. It occurs in the Upper Mercer Limestone Member of the Pottsville Group of the Pennsylvanian System. This chert is primarily a dark bluish-black but some varieties include white, light brown, and light gray mottling. Archaic Period Upper Mercer artifacts have been found throughout Ohio, eastern Indiana, northern Kentucky, northern West Virginia, western Pennsylvania, and western New York indicating a far-reaching utilization radius (Prufer and Long 1986).

Figure 9: Upper Mercer Chert (33ER0675, Object 1157.01) original photo in possession of the author.

In summary, the indigenous peoples that traversed across northwestern Ohio during the Early Archaic experienced a dry and flat deciduous landscape. These peoples likely traveled in groups of approximately 25 individuals and preferred upland locales for habitation. These bands tracked deer and elk, their primary source of nutrition, as the animals carried out their seasonal migrations. The ecosystem of northwestern Ohio allowed for these bands to take advantage of both aquatic and forest resources while they traveled through the region. In addition to its prolificity in sustenance, northwestern Ohio also was abundant in good-quality chert varieties. Chert was an important technological resource as it was required for the manufacture of the projectile points.

These tools were essential for the survival of Early Archaic peoples. Three projectile point styles define the cultural horizons for this period: the Kirk Horizon (ca. 9,500 to 8,900 B.P.), Large Bifurcate Horizon (ca. 9,000 to 8,500 B.P.), and Small Bifurcate Horizon (ca. 8,500 to 7,800 B.P.). The following chapter explores the existing theories regarding Early Archaic lifeways in northwestern Ohio with a focus on lithic raw material procurement and band mobility analyses.

Chapter 3: Theoretical Background

Dr. Matthew Purtill's "The Ohio Archaic: A Review" (2009) is the most recent comprehensive overview of Archaic Period research in Ohio. This resource is recommended for further information regarding Ohio's Early Archaic chronology, paleoenvironment, material culture studies, and demography. Here, additions will be made to Purtill's summary of the past research efforts on this topic, with a more recent debate about this period in northwestern Ohio. The chapter will then continue with an overview of previously conducted lithic raw material procurement studies and conclude with a discussion on Least Cost Path (LCP) analyses.

3.1 The Current Understanding of Ohio's Early Archaic Period

Research on the Early Archaic Period of Ohio has been sparse. Until the late 1960s, the Raisch-Smith site report (Moffett 1949) was the only major discussion of the period. At the start of the 1970s, two statewide syntheses of Archaic Period data (Blank 1970; Geistweit 1970) were completed. These two studies provided structure to the period but lacked good temporal control. The aggregated data was collected mostly from surface scatters and lacked stratigraphic and absolute dating[2] support. Since then, cultural resource management surveys have continued to collect Archaic Period data but there has been little attempt at synthesis. For this reason, Purtill suggests that Archaic Period research in Ohio continues to be "poorly focused and mired in normative thought[3] (2009:565)." For instance, the current understanding of Ohio's Archaic band populations is based on a generally applied framework following the premise is that Archaic bands were small and highly mobile at the start of the period, but as populations grew, became less mobile

[2] The process of determining an age of an object using its chemical or physical properties, such as radiocarbon dating.
[3] A theoretical approach that defines culture as a set of norms expressed by material remains and which generalizes societal changes.

and more sedentary. In addition to his concerns on data synthesis, Purtill also suggests that the validity of this normative framework should be tested to see if it is equally represented across the state (2009).

The last extensive review of Early Archaic period research in northwestern Ohio was published in the early 2000s (Stothers et al. 2001). In this work, Stothers, Abel, and Schneider discussed the cultural evolution of the Archaic Period in the Western Lake Erie Region.[4] The perspectives put forward in this work are generally agreed upon with the exception of Dr. David Stothers' Early Archaic colonization hypothesis.

Stothers published his theory on the colonization of northern Ohio in the mid-90s (Stothers 1996). Stothers claimed that the dominance of Upper Mercer chert in Kirk and Large Bifurcate Horizon toolkits suggested a strong preference for and a direct embedded procurement of the resource. His hypothesis was supported by the generally applied theory that Archaic bands were highly mobile because Upper Mercer is located roughly 115-km (70-mi) from northern Ohio. He reasoned that when assemblages are dominated by non-local chert types, direct procurement is more likely than indirect procurement through trade, exchange, or other band interaction and vice versa. Therefore, he concluded the prevalence of tools manufactured from Upper Mercer chert in northwestern Ohio is most likely explained by a population influx from the south during a colonization event.

In 2011, Dr. Robert Chidester reported on the results of a Phase III data recovery investigation at the Limes site (33LU759) in Lucas County, Ohio (Chidester 2011). Four Early Archaic projectile points were recovered from the site. Three of the four points were manufactured

[4] The Western Lake Erie Region encompasses southeastern Michigan, southwestern Ontario, northeastern Indiana, and northwestern Ohio.

from local chert types while one was manufactured from Upper Mercer. Chidester concluded that, while the sample size of the Early Archaic projectile points was small, the findings were still interestingly contradictory to Stothers' claim for "a striking predominance of exotic cherts over local cherts in Early Archaic tool assemblages in northwestern Ohio" (Stothers 1996:174, quoted in Chidester 2011:125).

New evidence from recent archaeological investigations in northwestern Ohio by The Mannik & Smith Group, Inc. (Chidester 2021a, 2021b, 2022; Hickle et al. 2023) supports Chidester's suggestion that Stothers' hypothesis should be revisited. These investigations resulted in the discovery of Early Archaic projectile points from Erie and Huron Counties that seemed to be manufactured from local cherts. A detailed analysis of these artifacts and the review of previously reported projectile point data (Bowen 1994; Stothers 1996) will be used to address this debate regarding Early Archaic chert preferences in northwestern Ohio. A basis for interpreting the results of the analyses will be provided by past research in lithic raw material procurement and band mobility.

3.2 Lithic Raw Material Procurement and Mobility Studies

Lithics, or stone tools, do not degrade quickly and are one of the most common artifacts encountered at an archaeological site. These artifacts can shed light on many aspects of human behavior. For instance, because the availability of lithic raw material, such as chert, differs across a landscape, sourcing the location of the material can infer the movement of people across a landscape. Consequently, a multitude of lithic raw material procurement studies have provided insight to the mobility of early human populations (Andrefsky 2008; Dowd 2013; Elston 2013; Goodyear 1979; Gramly 1988; Lepper et al. 2001; Mullet 2009; Seeman 1994; Sparks 2013).

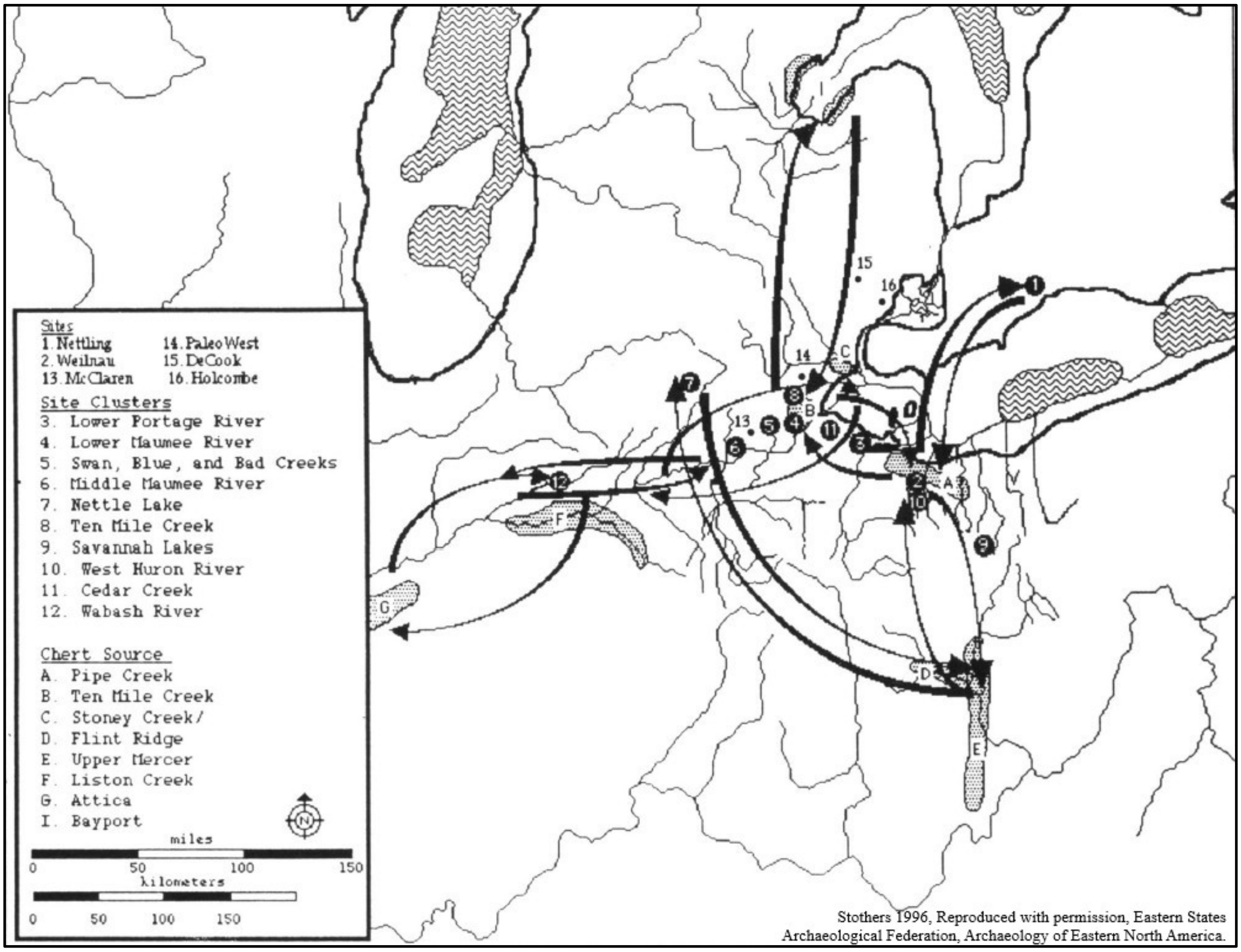
Lepper et al. (2001), Mullet (2009), and Seeman (1994) explore lithic procurement strategies in relation to Binford's (1979) proposed "embedded" and "disembedded" foraging strategies. In regards to lithic resources, embedded procurement describes the integration of quarry visits into planned hunting and gathering trips. The quarries would have been exploited "as needed" and "on the way" to other resource locations. Disembedded procurement describes intentional quarry trips for the sole purpose of retrieving raw materials or manufacturing tools. Each study concludes that the discard of heavily resharpened and worn-out tools manufactured from non-local lithic sources indicate that early human populations (Paleoindian and Archaic) used an embedded foraging strategy which allowed them to extend their mobility ranges.

As evident in these studies, examining the locality of lithic materials is a viable method in interpreting a population's foraging strategy. For instance, most researchers view Early Archaic groups as highly mobile but tethered to a select number of outcrops because of the wide distribution of non-local chert types. Whether the distribution of non-local chert types reflect migrations or seasonal band territories is still under debate (Purtill 2009). Additionally, the existence of worn-out tools manufactured from non-local cherts near other chert outcroppings has been observed by various researchers. In these studies, the presence of non-local cherts allowed for interpretations on hunter-gatherer foraging ranges or how social relationships allowed for the exchange of materials beyond these ranges (Elston 2013; Gramly 1980). According to Gramly (1980), the analysis of quarry sites is highly revealing of the duration and distance of population movements. The presence of finished tools manufactured from exotic raw materials at lithic workshops is evidence for mobile populations, where seasonal movement over considerable distances is a viable economic strategy. Meanwhile, assemblages with finished tools manufactured from local materials indicate a more settled population.

Whether quarry visits were embedded or disembedded or materials were procured directly or indirectly, lithic raw material procurement was certainly an integral part of early human subsistence strategies. Stone tools were necessary for hunting and plant and animal processing. Archaic bands would need to be familiar with the locations of quarries when it was time to replenish their toolkits. Therefore, the zone of exploitation for a specific lithic resource, referred to as a lithic supply zone, is directly related to the relative mobility of early humans. The modeling of these zones can reveal the likely distance of population movements (Bowen 1994; Gramly 1980, 1988, Seeman 1994; Stothers 1996).

Two of these studies, Bowen (1994) and Stothers (1996) are specific to the Early Archaic period in northwestern Ohio. Bowen accumulated projectile point find spot data for Large Bifurcate projectile points in the region and then used this data to propose the existence of an 80,000-km^2 (49,710-mi^2) Upper Mercer lithic supply zone centered on north-central Ohio. He found that 90.0% of the documented Large Bifurcate Horizon projectile points were manufactured from Upper Mercer chert with the remaining 10.0% manufactured from Flint Ridge, Pipe Creek, and Delaware chert. Similarly, Stothers used diagnostic tool styles and their raw material source locations to suggest several lithic supply zones which he refers to as band territories. He proposed that visits to different quarries reflected periodic seasonal band movements (Figure 10). The data from these studies will be synthesized with the results from the artifact analysis of the Pipe Creek quarry site tools. The synthesized data will then be used to conduct an LCP analysis for each Early Archaic horizon. The LCP results will then be compared to Stothers' suggested band territories to determine if the data provides new insight regarding the region's lithic supply zones.

Figure 10: Hypothesized Early Archaic Band Territories (Stothers 1996:196)
Reproduced with permission, Eastern States Archaeological Federation, Archaeology of Eastern North America



3.3 Using GIS to Map Lithic Supply Zones

In archaeological studies, Geographic Information System (GIS) technology has become an important tool in organizing and visualizing data regarding human behavior across landscapes (Ebert 2004). Least Cost Path analysis, sometimes referred to as cost-distance modeling, has become one of the more popular GIS tools in exploring the use of landscapes (White and Surface-Evans 2012). Two key theoretical concepts relevant to LCP analysis are the Principle of Least Effort (Zipf 1949) and Optimal Foraging Theory (Jeske 1992). These theories propose that humans will adopt a foraging strategy that provides the most benefit (resources) for the lowest cost (energy expended). LCP analysis assumes humans will attempt to limit the costs of travel and this assumption allows archaeologists to calculate and map potentially favored paths between different locations. However, these assumptions must also consider human responses to environmental or social travel barriers (Binford 1980).

Some researchers express wariness towards the use of GIS to calculate past travel routes through cost surfaces because of their inability to include certain aspects of human agency. Factors such as site visibility, nearby catchment zones, and political or religious boundaries are all known contributors in determining travel routes but are not always considered in LCP analyses. Other criticisms of LCP analysis are that the calculated paths may not represent legitimate travel routes and that this type of analysis assumes travelers had perfect knowledge of the landscapes they were traversing. Nonetheless, efforts have been made to address these concerns. Recommended solutions to these issues include ground-testing idealized paths; incorporating locations such as villages and religious sites into analyses; and agent-based analysis which simulates the actions of autonomous agents through computational modeling (Branting 2012; Surface-Evans 2012; Surface-Evans and White 2012; Verhagen 2012). These types of detailed approaches have allowed for LCP analysis to be successfully utilized as an exploratory heuristic device.[5] In short, although LCP analysis can present an overly simplified understanding of the past, it is not without utility. And while LCP techniques may not yet be able to develop theory, they could have a role in testing theory.

For example, Dr. John Rissetto used an LCP analysis to reinterpret Paleolithic procurement zones in Northern Spain (2012). The first step of his analysis was to source the lithic raw materials found at the habitation sites included in his study. Then, a cost-surface was created with a Digital

[5] A heuristic device is a tool that models artificial constructs to explore social phenomena.

Elevation Model (DEM). The LCP analysis was conducted between the known habitation sites and the identified lithic source areas. The results supported the hypothesis that the Paleoindian bands traveled farther than the previously assumed 25-km (16-mi) procurement radius around their habitation sites to forage for lithic materials.

In this thesis, Rissetto's methods will be used to investigate the Early Archaic lithic supply zones of northwestern Ohio. An LCP analysis will be conducted with ArcGIS 3.2 to create energetically efficient travel paths between chert source locations and projectile point find spots. The aim of this study is not to propose legitimate travel routes, but to assess possible movement patterns between chert source locations.

Chapter 4: Methodology and Data Collection

The following analyses were conducted to investigate changes in chert preferences and lithic supply zone extents throughout the Early Archaic horizons in northwestern Ohio. The first step in this investigation was to identify the raw material types of the Early Archaic Period projectile points from five recently documented quarry sites in northwestern Ohio. Then, the results from this analysis were tabulated along with the projectile point data from Bowen (1994), Chidester (2011), and Stothers (1996) for comparison. The geographic coordinates for all of the tabulated projectile points were then integrated into GIS software in preparation for an LCP analysis.

4.1 Data Collection: Artifact Analysis

A series of large Phase I cultural resources surveys undertaken by The Mannik & Smith Group, Inc. (MSG) resulted in the identification of 378 archaeological sites in Erie and Huron Counties, Ohio. Five of these sites, 33ER0675, 33HU0036, 33HU0047, 33HU0048, and 33HU0849, were identified as Pipe Creek quarries or proximal lithic workshops (Chidester et al. 2021a, 2021b, 2022; Hickle et al. 2023). The initial artifact analysis for these sites was conducted by MSG archaeologist Ryan Botkin. This analysis included preliminary determinations for artifact type (e.g., debitage or formal tool); sub-type (e.g., projectile point or knife); material type (e.g., groundstone or chert); material-subtype (e.g., groundstone or chert type); artifact descriptions, examination for heat-treatment, heat damage, utilization, and retouch; weight, count, formal tool metrics, and the artifact's assumed temporal affiliation. As a result, projectile points diagnostic to the Early Archaic Period were identified. This data was submitted to the Ohio Archaeological Inventory (OAI) database and has since been archived.

For the purpose of this study, a secondary analysis of the artifacts was conducted with a detailed focus on projectile point style, chert type, and tool retouch. Justice (1987) was consulted to identify the projectile point styles. Then, methodologies proposed by Andrefsky (2006), Kagelmacher (2000), and Luedtke (1979) were used to macroscopically examine physical characteristics of chert such as color, texture, luster, inclusions, fossils, and phenocrysts (large crystals). These characteristics can indicate from which outcropping the chert originated. It should be noted that although some chert types can be identified by their physical characteristics, there are some instances in which different varieties of chert are so similar they cannot be accurately identified without further microscopic or chemical study. In these instances, the provenience of the chert was taken into consideration to best identify the material. Lastly, I examined each tool under magnification (45x) for evidence of retouch or the intentional modification of a tool's edge for resharpening (Andrefsky 2006). These efforts resulted in some changes to the preliminary data, including the addition of my own observations. The results of this analysis can be seen in Chapter 5, Table 1.

4.2 Data Collection: Literature Review

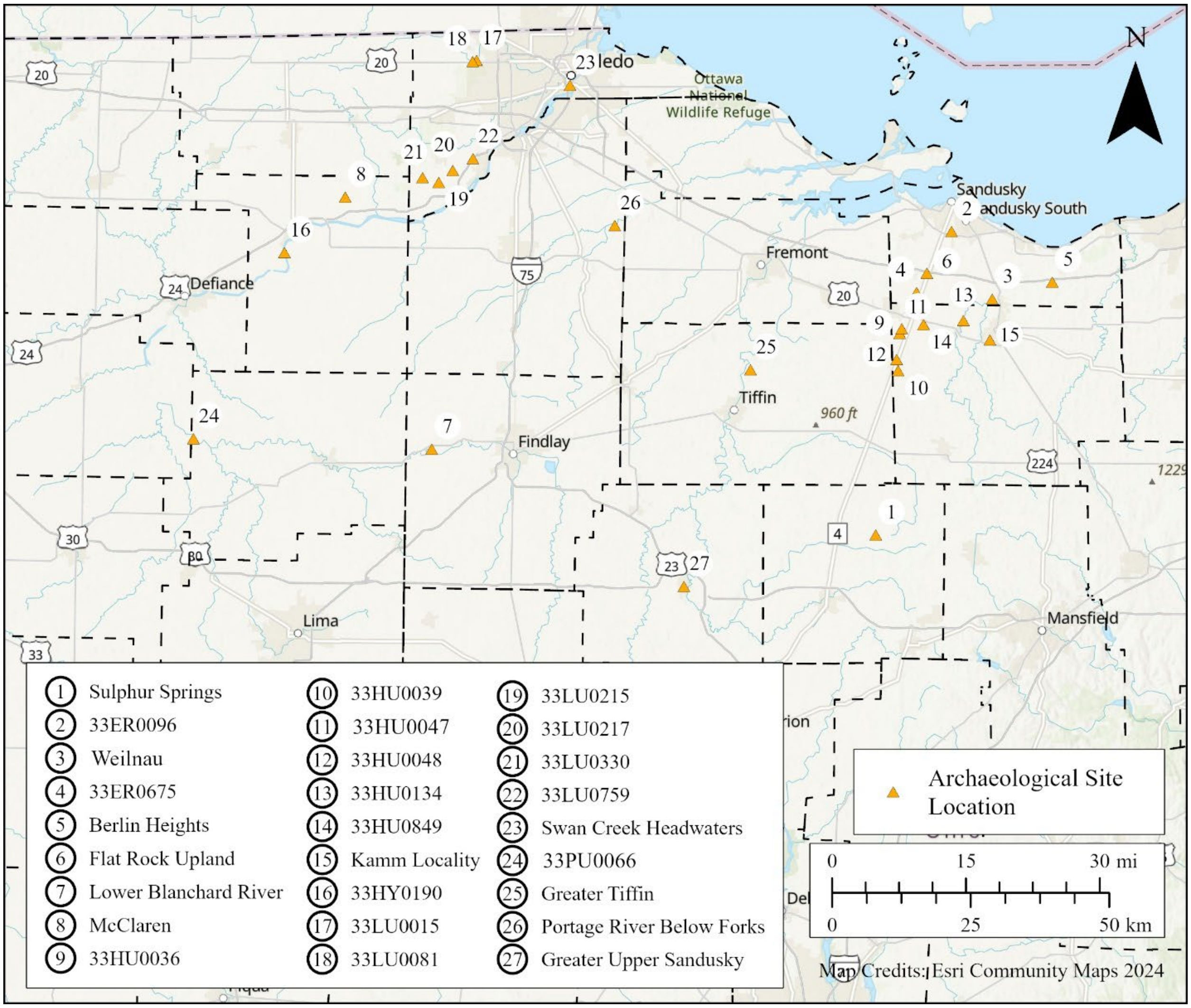
To contextualize the results from the artifact analysis, datasets were created to integrate the results with data from other regional studies (Bowen 1994; Chidester 2011; Stothers 1996). The integrated datasets were organized by tool horizon to allow for comparison between the three Early Archaic horizons.

This effort resulted in additional data from 22 sites within the region. Thus, 27 sites in total were incorporated in this study (Figure 11). These sites include: one Crawford County site cluster (Sulphur Springs), three Erie County sites and two site clusters (33ER0096, 33ER0409, 33ER0675, Berlin Heights, and Flat Rock Upland), one Hancock County site cluster (Lower

Blanchard River), two Henry County sites (McClaren and 33HY0190), two Huron County sites and one site cluster (33HU0036, 33HU0039, 33HU0047, 33HU0048, 33HU0134, 33HU0849, and the Kamm Locality), six Lucas County sites and one site cluster (33LU0015, 33LU0081, 33LU0215, 33LU0217, 33LU0330, 33LU0759, and Swan Creek Headwaters), one Putnam County site (33PU0066), one Seneca County site cluster (Greater Tiffin), one Wood County site cluster (Portage River Below Forks), and one Wyandot County site cluster (Greater Upper Sandusky). These sites were mainly isolated surface finds or surface collections documented during reconnaissance-level surveys. The data retrieved from these sites can be viewed in Chapter 5 (Tables 2, 4, and 6).

Brent Eberhard, The Archaeology Survey and Data Manager for the Ohio State Historic Preservation Office (OHPO), provided Ohio Archeological Inventory (OAI) forms and the centroid coordinates for each archaeological site. When coordinate data was not available, the sketch maps and descriptions of the sites were used to approximate the location of the site. Bloomville, Pipe Creek, Flint Ridge, and Upper Mercer outcropping locations were mapped with coordinates from Kagelmacher (2000) while Delaware and Ten Mile Creek outcropping locations were mapped according to Stout and Schoenlaub (1945) descriptions. Because the locations of archaeological sites are confidential, the coordinates for the chert outcroppings and sites included in this study will not be disclosed.

Figure 11: Early Archaic Sites of Northwest Ohio (map by the author)



<u>*4.3 Least Cost Path Analysis*</u>

The LCP analysis conducted for this study was modeled after the methodologies of Rissetto (2012) and Surface-Evans (2012). In accordance with these methods, analysis began with the creation of a study environment. This process was two-fold. First, the locations of the archaeological sites and chert resource locations included in the study were mapped. This was done by the creation of two feature classes, one class for sites and one for resources. These are the locations that will be traveled between by the hypothetical traveler algorithm.

Second, a cost-surface was created to replicate travel barriers that Archaic bands may have experienced. In this study, cost was defined as cumulative distance. Topographic slope was considered as a travel barrier, as an increase in slope also increases the expenditure of energy (energy cost). The cost surface was constructed by adding a 30-m resolution Digital Elevation Model (DEM) of Ohio (ODNR 2023) as a raster[6] layer. A DEM represents changes in the topographic surface, or slope, of Earth's ground surface. Each cell[7] of the raster is assigned a weighted numerical value dependent on its slope value. Cells with high slope value would generally be avoided by a hypothetical traveler algorithm.

Major rivers and Lake Erie were not considered as barriers to travel and were allowed for traversing at a low cost by handling zero cost cells as small positives. This was done for two reasons, one being that the meandering of major rivers during the Early Archaic Period could not be accurately modeled, and the other being that the possibility of water travel during this period is unknown. Vegetation barriers could also not be replicated and were not considered as a cost-surface variable.

Once locations are mapped and a cost-surface is created, the Least Cost Path (AllSource Tools) geoprocessing tool can run. This tool has an embedded Euclidean distance algorithm which will calculate the least cost path between two chosen locations (an archaeological site and chert source location). Euclidean distance is calculated from the center of the source point to the center of the surrounding cells. The distance to each source cell is determined by calculating the hypotenuse between the center points. The algorithm follows the path of low-cost hypotenuse values through an exhaustive scanning process of the entire cost surface and then the shortest

[6] A raster is a matrix of cells, sometimes referred to as a digital image or map.
[7] A cell is the smallest unit of information in a raster which would be a 30x30 m square for a 30m DEM.

distance to the destination point is determined. A least cost path is assigned to the route with the lowest accumulated distance, and therefore lowest cost, traveled (ESRI 2023).

An LCP analysis was conducted for each Early Archaic horizon to observe differences in hypothetical travel paths between the three horizons. Each LCP was conducted in the North American Datum (NAD) 1983 (2011) Ohio State Plane North Meters (WKID 6548) projection. The paths were calculated from the quarry locations to the archaeological sites. The results of these analyses can be viewed in Figures 16-18 and will be discussed in the following chapter.

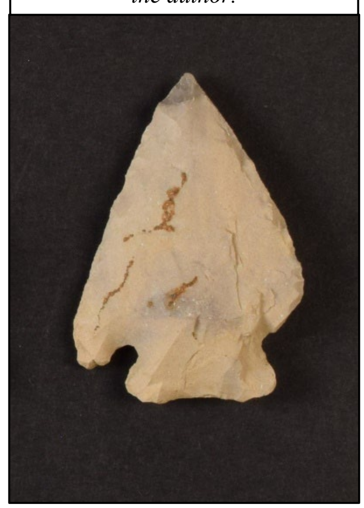
Chapter 5: Results

The results of the artifact analysis, regional projectile point data synthesis, and LCP analyses are presented in this chapter. A description of the raw material types discovered at five Pipe Creek quarry sites precedes the summaries of regional data and LCP outcomes for each Early Archaic horizon. The results of these analyses indicated changes in chert preference and lithic supply zones throughout the three Early Archaic Horizons.

5.1 Chert Identification Results

The morphologies and material types of 24 Early Archaic projectile points from a cluster of five Pipe Creek chert quarry sites (33ER0675, 33HU0036, 33HU0047, 33HU0048, and 33HU0849) located in northwestern Ohio (see Figure 11) were identified during artifact analysis (Table 1). This group of chronologically- and geographically-associated points provides the data set for further analysis in this thesis. The majority of these projectile points were determined to be Kirk Horizon tools (n=21, 87.5% of the total assemblage). The Kirk Horizon assemblage consisted of 16 Kirk Corner-notched points, three Palmer Corner-notched points, and two Decatur points. Ten of the points were manufactured from Bloomville chert (47.6% of the Kirk assemblage), five were manufactured from Delaware chert (23.8% of the Kirk assemblage) (Figure 12), three were manufactured from Upper Mercer chert (14.3% of the Kirk assemblage), two were manufactured from Pipe Creek chert (9.5% of the Kirk assemblage), and one was manufactured from Flint Ridge Chalcedony chert (4.8% of the Kirk assemblage). Only two Kirk

Figure 12: Kirk Corner-notched Point, Delaware Chert (33HU0849, Object 3351.01), original photo in the possession of the author.



points were nearly complete (one manufactured from Delaware and the other Pipe Creek chert), with the remainder being broken or heavily utilized. Sixteen of these points were retouched (resharpened) and seven points were repurposed into a hafted end scraper before discard (Figure 13).

There was only one Large Bifurcate Horizon tool (4.2% of the total assemblage), a St. Albans Side-notched point, which was manufactured from Pipe Creek chert. This tool had visible evidence of retouch (Figure 14).

Two points were determined to belong to the Small Bifurcate Horizon (8.3% of the total assemblage). Both points were identified as Lake Erie Bifurcated Base points. One point was manufactured from Upper Mercer chert (Figure 15) and the other was manufactured from Pipe Creek chert. The Upper Mercer point showed visible evidence of retouch while the Pipe Creek point did not. The results of this analysis can be viewed in Table 1. Detailed images of all of the described projectile points are included in Appendix A, Figures A1-A4.

Figure 15: Kirk Corner-notched Hafted Scraper, Bloomville Chert (33HU0849, Object 3353.01), original photo in possession of the author.

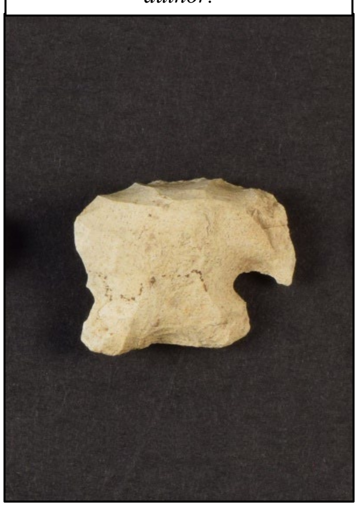


Figure 14: St. Albans Point, Pipe Creek Chert (33HU0036, Object 3049.01), original photo in possession of the author.

Figure 13: Lake Erie Bifurcated Base Point, Upper Mercer Chert (33HU0047, Object 2872.01), original photo in possession of the author.

Table 1: Artifact Analysis Results

Site #	Object #	Projectile Point Type	Material Type	Retouched	Length (mm)	Width (mm)	Thickness (mm)	Weight (g)	Tool Horizon	Temporal Range	Notes
33ER0675	1146.01	Kirk Corner-notched	Upper Mercer	Yes	17.17	26.54	6.81	3.0	Kirk	9500 - 8900 B.P.	Broken projectile point repurposed into a hafted end scraper.
33ER0675	1153.01	Kirk Corner-notched	Bloomville	Yes	19.30	27.13	7.38	3.8	Kirk	9500 - 8900 B.P.	Broken projectile point repurposed into a hafted end scraper.
33ER0675	1155.01	Kirk Corner-notched	Bloomville	Yes	20.93	28.36	6.58	4.3	Kirk	9500 - 8900 B.P.	Broken projectile point repurposed into a hafted end scraper.
33ER0675	1156.01	Kirk Corner-notched	Bloomville	Yes	20.62	27.48	6.09	3.8	Kirk	9500 - 8900 B.P.	Broken projectile point repurposed into a hafted end scraper.
33ER0675	1157.01	Kirk Corner-notched	Upper Mercer	Yes	22.20	29.70	6.16	5.0	Kirk	9500 - 8900 B.P.	Broken projectile point repurposed into a hafted end scraper.
33ER0675	1164.01	Kirk Corner-notched	Delaware	Yes	21.97	26.89	7.18	4.1	Kirk	9500 - 8900 B.P.	Broken projectile point repurposed into a hafted end scraper.
33HU0048	1657.01	Kirk Corner-notched	Bloomville	Yes	37.68	24.41	5.54	4.6	Kirk	9500 - 8900 B.P.	One ear has been broken.
33HU0048	2524.01	Decatur	Upper Mercer	Yes	37.84	23.33	5.97	4.1	Kirk	9500 - 8900 B.P.	Broken at the base. One of the blades appears to have been retouched for use as a spokeshave.
33HU0048	2546.01	Kirk Corner-notched	Delaware	No	29.05	27.29	8.73	5.8	Kirk	9500 - 8900 B.P.	Broken in half.
33HU0047	2871.01	Decatur	Bloomville	Yes	30.13	25.36	6.82	4.8	Kirk	9500 - 8900 B.P.	Broken in half.
33HU0047	2873.01	Palmer Corner-notched	Bloomville	Yes	26.97	20.20	5.77	2.7	Kirk	9500 - 8900 B.P.	Broken barb.
33HU0036	3051.01	Palmer Corner-notched	Flint Ridge Chalcedony	Yes	24.10	17.80	4.90	2.3	Kirk	9500 - 8900 B.P.	Small size may indicate heavy retouch and use.
33HU0036	3053.01	Palmer Corner-notched	Bloomville	Yes	17.70	21.20	4.60	2.1	Kirk	9500 - 8900 B.P.	Small size may indicate heavy retouch and use.
33HU0849	3349.02	Kirk Corner-notched	Pipe Creek	No	42.50	25.22	7.50	7.5	Kirk	9500 - 8900 B.P.	Nearly complete except for small break at the tip.
33HU0849	3351.01	Kirk Corner-notched	Delaware	Yes	44.00	30.76	7.81	8.9	Kirk	9500 - 8900 B.P.	Nearly complete except for broken barb.

Site #	Object #	Projectile Point Type	Material Type	Retouched	Length (mm)	Width (mm)	Thickness (mm)	Weight (g)	Tool Horizon	Temporal Range	Notes
33HU0849	3353.01	Kirk Corner-notched	Bloomville	Yes	19.60	25.73	8.25	3.8	Kirk	9500 - 8900 B.P.	Broken projectile point repurposed into a hafted end scraper.
33HU0849	3354.01	Kirk Corner-notched	Delaware	Yes	29.23	30.69	7.00	5.9	Kirk	9500 - 8900 B.P.	Broken in half.
33HU0849	3355.01	Kirk Corner-notched	Bloomville	Yes	24.32	26.55	7.49	4.5	Kirk	9500 - 8900 B.P.	Broken in half. Rounded barbs.
33HU0849	3360.01	Kirk Corner-notched	Pipe Creek	No	23.74	24.16	7.01	4.3	Kirk	9500 - 8900 B.P.	Broken in half along large hematite inclusion.
33HU0849	3361.01	Kirk Corner-notched	Bloomville	No	39.48	28.82	6.82	6.7	Kirk	9500 - 8900 B.P.	Nearly complete except for broken barb.
33HU0849	3364.01	Kirk Corner-notched	Delaware	No	15.88	15.29	6.82	1.9	Kirk	9500 - 8900 B.P.	Only half of base and one barb present.
33HU0036	3049.01	St. Albans Side-notched	Pipe Creek	Yes	36.30	19.20	5.60	2.7	Large Bifurcate	8900 - 8500 B.P.	
33HU0047	2872.01	Lake Erie Bifurcated Base	Upper Mercer	Yes	30.99	24.28	6.11	4.6	Small Bifurcate	8300 - 7800 B.P.	
33HU0036	3052.01	Lake Erie Bifurcated Base	Pipe Creek	No	24.60	17.20	4.20	2.3	Small Bifurcate	8300 - 7800 B.P.	Broken tip.

5.2 Kirk Horizon Point Data and LCP Results

Integrating the artifact analysis results with existing regional data produced a more thorough overview of Early Archaic projectile point findings in northwestern Ohio. This effort resulted in the aggregation of 235 Kirk Horizon (ca. 9,500 to 8,900 B.P.) projectile point identifications (Table 2). Local cherts made up a majority of the assemblage (n=225, 95.7%) while non-local chert types were the minority (n=10, 4.3%). This observation holds true even when disregarding the outlier of the 200 Pipe Creek chert points found at one site (n=25, 71.4%). Ten points were manufactured from Bloomville chert (4.3%), six points were manufactured from Delaware chert (2.6%), 204 points were manufactured from Pipe Creek chert (86.8%), five were manufactured from Ten Mile Creek chert (4.3%), two were manufactured from Flint Ridge chert (0.9%), and eight were manufactured from Upper Mercer chert (3.4%).

The Kirk Horizon points were collected from 12 sites within northwestern Ohio. One site is located in Erie County, two sites in Henry County, five sites in Huron County, and four sites in Lucas County. The LCP analysis calculated the most energetically efficient path between the chert source location and the projectile point find spots (Table 3). The resulting lengths of the least cost paths (LCPs) indicate a concentration of Bloomville tool manufacture within 33-km (21-mi) from the cherts primary outcropping. Delaware chert traveled 27-km (17-mi) southward and 90-km (56-mi) westward. Pipe Creek chert was discovered as far as 104-km (65-km) westward from its source location. The use of Ten Mile Creek chert was concentrated within 50-km (31-mi) of its primary outcropping, along the Maumee River watershed. Both Flint Ridge and Upper Mercer cherts were discovered over 200-km (226-km [140-mi] and 218-km [135-mi]), respectively) away from their source location. One of the LCPs for Flint Ridge chert and all of the LCPs for Upper Mercer chert followed along Mohican River tributaries to the north (Figure 16).

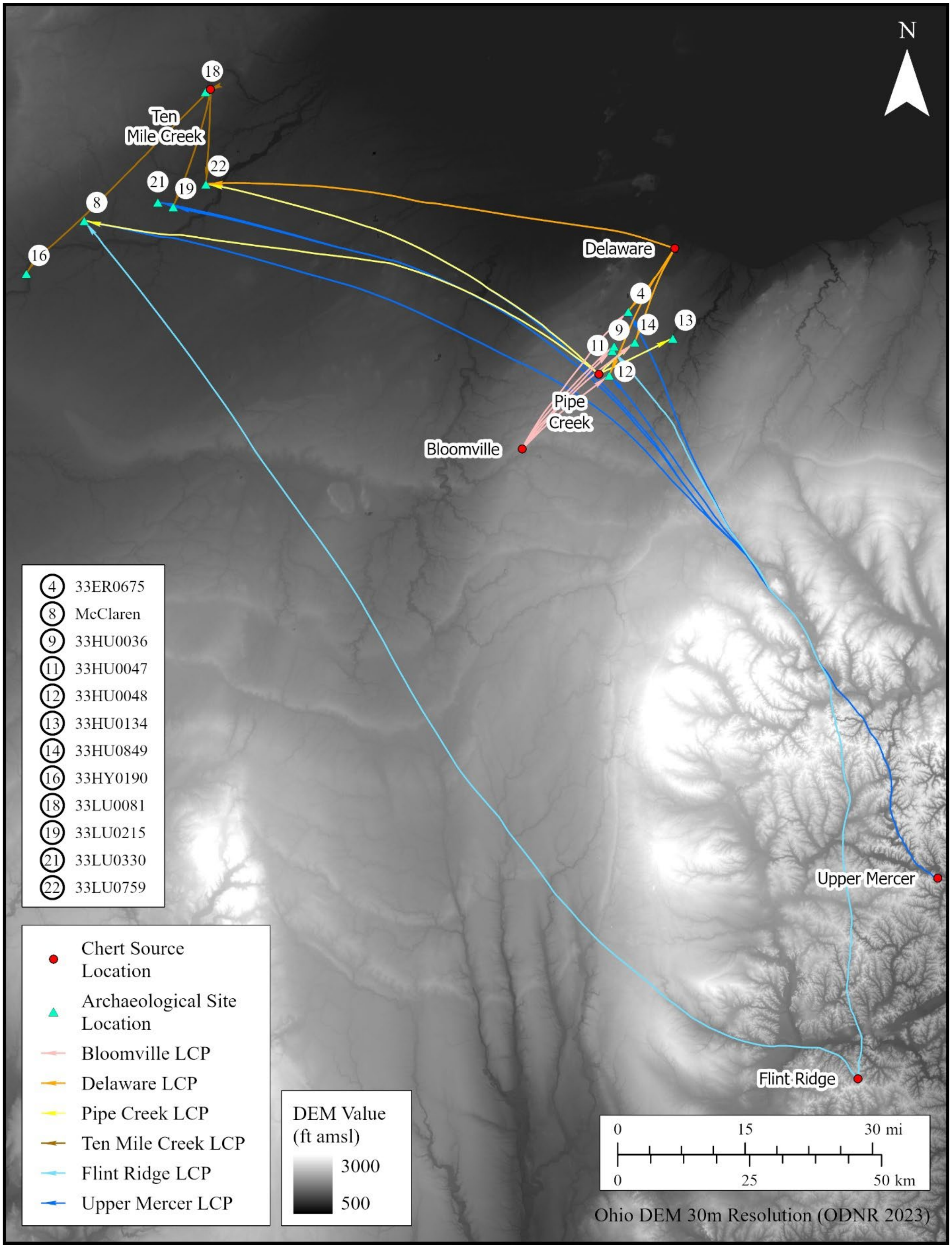
Table 2: Kirk Horizon Projectile Point Data

Map Key #	Site Name	County	Reference	Local Chert Types				Non-Local Chert Types		Total
				Bloomville	**Delaware**	**Pipe Creek**	**Ten Mile**	**Flint Ridge**	**Upper Mercer**	
4	33ER0675	Erie	Personal analysis, Chidester et al. 2021a	3	1	0	0	0	2	6
8	McClaren	Henry	Stothers 1996	0	0	1	0	1	2	4
9	33HU0036 (Werner Quarry)	Huron	Personal analysis, Chidester et al. 2021a, 2021b	1	0	0	0	1	0	2
11	33HU0047 (Lepley Quarry)	Huron	Personal analysis, Chidester et al. 2021a, 2021b	2	0	0	0	0	0	2
12	33HU0048 (Shingledecker Quarry)	Huron	Personal analysis, Chidester et al. 2021a, 2022	1	1	0	0	0	1	3
13	33HU0134 (F-3 Site)	Huron	Stothers 1996	0	0	200	0	0	0	200
14	33HU0849	Huron	Personal analysis, Hickle et al. 2023	3	3	2	0	0	0	8
16	33HY0190 (Palmer Site)	Henry	Stothers 1996	0	0	0	2	0	0	2
18	33LU0081 (Site Deception)	Lucas	Stothers 1996	0	0	0	1	0	0	1
19	33LU0215 (Burial Ridge)	Lucas	Stothers 1996	0	0	0	1	0	1	2
21	33LU0330 (Heurman)	Lucas	Stothers 1996	0	0	0	0	0	1	1
22	33LU0759 (Limes Site)	Lucas	Chidester 2011	0	1	1	1	0	1	4
Total				10	6	204	5	2	8	**235**
				225				**10**		

Table 3: Kirk Horizon Least Cost Path Results

Chert Source Location	Destination Site	LCP Distance (km)	LCP Distance (mi)
Bloomville	**33ER0675**	**33.05**	**20.53**
	33HU0849	29.54	18.35
	33HU0047	26.30	16.34
	33HU0036	25.35	15.75
	33HU0048	21.67	13.47
Delaware	**33LU0759**	**90.04**	**55.95**
	33ER0675	14.82	9.20
	33HU0849	19.28	11.98
	33HU0048	27.05	16.81
Pipe Creek	33LU0759	84.09	52.25
	McClaren	**103.68**	**64.43**
	33HU0134	15.63	9.71
	33HU0849	9.18	5.70
Ten Mile Creek	33LU0081	1.05	0.65
	33LU0759	17.95	11.16
	33LU0215	23.37	14.52
	33HY0190	**49.42**	**30.71**
Flint Ridge	**McClaren**	**226.00**	**140.44**
	33HU0036	152.18	94.56
Upper Mercer	33LU0759	201.70	125.33
	33LU0330	208.08	129.30
	33LU0215	205.02	127.40
	McClaren	**217.54**	**135.17**
	33ER0675	124.91	77.62
	33HU0048	116.38	72.31

Figure 16: Kirk Horizon Least Cost Path Results



5.3 Large Bifurcate Horizon Point Data and LCP Results

The aggregation of Large Bifurcate Horizon (ca. 9,000 to 8,500 B.P.) projectile point data resulted in the identification of 284 points across the region (Table 4). Upper Mercer chert made up a majority of the assemblage (n=261, 91.9%), while Flint Ridge chert (n=8, 2.8%) and local chert types were the minority (n=15, 5.3%). Two points were manufactured from Delaware chert (0.7%), 11 points were manufactured from Pipe Creek chert (3.9%), and two were manufactured from Ten Mile Creek chert (0.7%). No points were manufactured from Bloomville chert.

The Large Bifurcate Horizon points were collected from 19 sites within northwestern Ohio. One site is located in Crawford County, three sites in Erie County, one site in Hancock County, one site in Henry County, four sites in Huron County, five sites in Lucas County, one site in Putnam County, one site in Seneca County, one site in Wood County, and one site in Wyandot County. The LCP analysis calculated the most energetically efficient path between the chert source location and the projectile point find spots (Table 5). The resulting lengths of the LCPs indicate that Delaware chert traveled 94-km (58-mi) westward from its primary outcropping. Pipe Creek chert was discovered as far as 110-km (69-mi) away from its source location, also towards the western part of the region. The use of Ten Mile Creek chert was concentrated within 24-km (15-mi) of its primary outcropping, again traveling south along the Maumee River watershed. Flint Ridge chert was discovered as far as 158-km (98-mi) north and 128-km (79-mi) northwest from its source location. Upper Mercer was discovered at all but one of the archaeological sites for this horizon. The Upper Mercer LCPs extended as far as 212-km (132-mi) northwest and north-northwest from the source location (Figure 17).

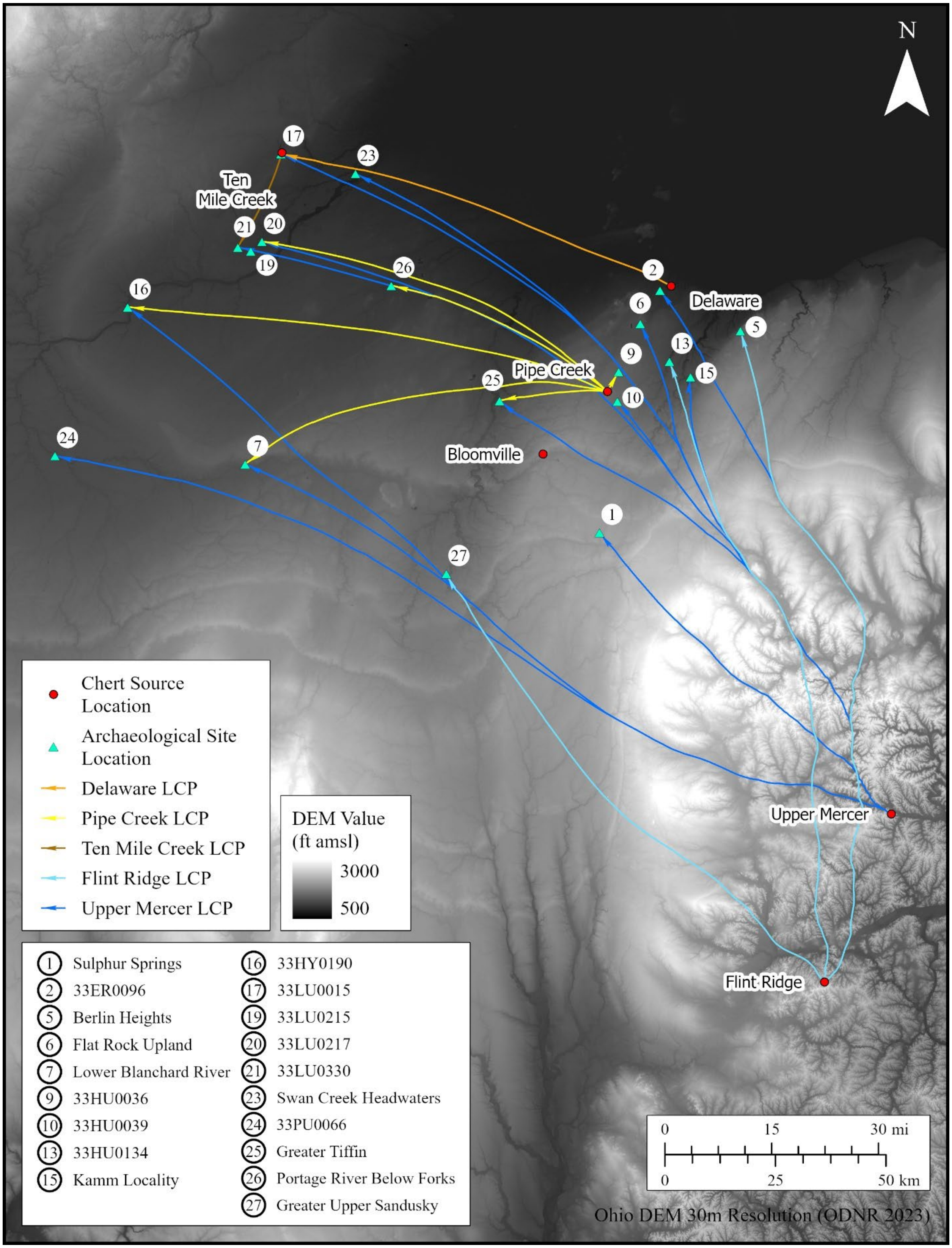
Table 4: Large Bifurcate Horizon Projectile Point Data

Map Key #	Site Name	County	Reference	Local Chert Types				Non-Local Chert Types		Total
				Bloomville	Delaware	Pipe Creek	Ten Mile Creek	Flint Ridge	Upper Mercer	
1	Sulphur Springs Site Cluster	Crawford	Bowen 1994	0	0	0	0	0	20	20
2	33ER0096 (Puckerin No. 1)	Erie	Bowen 1994	0	0	0	0	0	20	20
5	Berlin Heights Site Cluster	Erie	Bowen 1994	0	0	0	0	3	25	28
6	Flat Rock Upland Site Cluster	Erie	Bowen 1994	0	0	0	0	0	19	19
7	Lower Blanchard River Site Cluster	Hancock	Bowen 1994	0	0	1	0	0	16	17
9	33HU0036 (Werner Quarry)	Huron	Personal analysis, Chidester et al. 2021a, 2021b	0	0	1	0	0	0	1
10	33HU0039 (Didion Site 1)	Huron	Bowen 1994	0	0	0	0	0	20	20
13	33HU0134 (F-3 Site)	Huron	Stothers 1996	0	0	0	0	2	0	2
15	Kamm Locality Site Cluster	Huron	Bowen 1994	0	0	0	0	0	9	9
16	33HY0190 (Palmer Site)	Henry	Stothers 1996	0	0	3	0	0	4	7
17	33LU0015 (Ten Mile Creek)	Lucas	Stothers 1996	0	2	0	1	0	5	8
19	33LU0215 (Burial Ridge)	Lucas	Stothers 1996	0	0	0	0	0	3	3
20	33LU0217 (Workhouse Hill #1)	Lucas	Stothers 1996	0	0	1	0	0	7	8
21	33LU0330 (Heurman)	Lucas	Stothers 1996	0	0	0	1	0	1	2
23	Swan Creek Headwaters Site Cluster	Lucas	Bowen 1994	0	0	0	0	0	16	16
24	33PU0066 (Fitzwater I)	Putnam	Bowen 1994	0	0	0	0	0	20	20
25	Greater Tiffin Site Cluster	Seneca	Bowen 1994	0	0	2	0	0	29	31
26	Portage River Below Forks Site Cluster	Wood	Bowen 1994	0	0	3	0	0	16	19
27	Greater Upper Sandusky Site Cluster	Wyandot	Bowen 1994	0	0	0	0	3	31	34
Total				0	2	11	2	8	261	**284**
				15				**269**		

Table 5: Large Bifurcate Horizon Least Cost Path Results

Chert Source Location	Destination Site	LCP Distance (km)	LCP Distance (mi)
Delaware	**33LU0015**	**93.54**	**58.12**
Pipe Creek	33LU0217	86.73	53.90
	Portage River Below Forks	55.00	34.18
	33HY0190	**110.73**	**68.80**
	33HU0036	5.20	3.23
	Greater Tiffin	24.54	15.25
	Lower Blanchard River	85.80	53.31
Ten Mile Creek	33LU0015	0.34	0.21
	33LU0330	**23.68**	**14.72**
Flint Ridge	**Berlin Heights**	**158.11**	**98.25**
	33HU0134	149.05	92.61
	Greater Upper Sandusky	127.73	79.37
Upper Mercer	**33LU0015**	**212.10**	**131.79**
	Swan Creek Headwaters	195.37	121.40
	33LU0217	203.20	126.27
	33LU0330	208.08	129.29
	Portage River Below Forks	172.29	107.06
	33ER0096	136.28	84.68
	33HY0190	211.44	131.38
	Flat Rock Upland	127.60	79.29
	Berlin Heights	120.87	75.11
	Kamm Locality	112.63	69.99
	Greater Tiffin	134.65	83.67
	33HU0039	114.65	71.24
	33PU0066	208.65	129.65
	Lower Blanchard River	168.97	104.88
	Sulphur Springs	92.91	57.73
	Greater Upper Sandusky	117.57	73.05

Figure 17: Large Bifurcate Horizon Least Cost Path Results



5.4 Small Bifurcate Horizon Point Data and LCP Results

The aggregation of Small Bifurcate Horizon (ca. 8,500 to 7,800 B.P.) projectile point data resulted in the identification of 21 points across the region (Table 6). Local cherts made up a majority of the assemblage (n=18, 85.7%) while non-local chert types were the minority (n=3, 14.3%). One point was manufactured from Delaware chert (4.8%), 11 points were manufactured from Pipe Creek chert (52.4%), six were manufactured from Ten Mile Creek chert (28.5%), and three were manufactured from Upper Mercer chert (14.3%). No points were manufactured from Bloomville or Flint Ridge cherts.

The Small Bifurcate Horizon points were collected from eight sites within northwestern Ohio. One site is located in Erie County, one site in Henry County, three sites in Huron County, and three sites in Lucas County. The LCP analysis calculated the most energetically efficient path between the chert source location and the projectile point find spots (Table 7). The resulting lengths of the LCPs indicate that Delaware chert traveled as far as 125-km (78-mi) westward. Pipe Creek chert was discovered as far as 111-km (69-mi) away from its source location, towards the western part of the region. The use of Ten Mile Creek chert was concentrated within 50-km (31-mi) of its primary outcropping, traveling south along the Maumee River watershed. Upper Mercer chert was discovered 120-km (75-mi) northwest of its source location, traveling north along the Mohican River watershed (Figure 18).

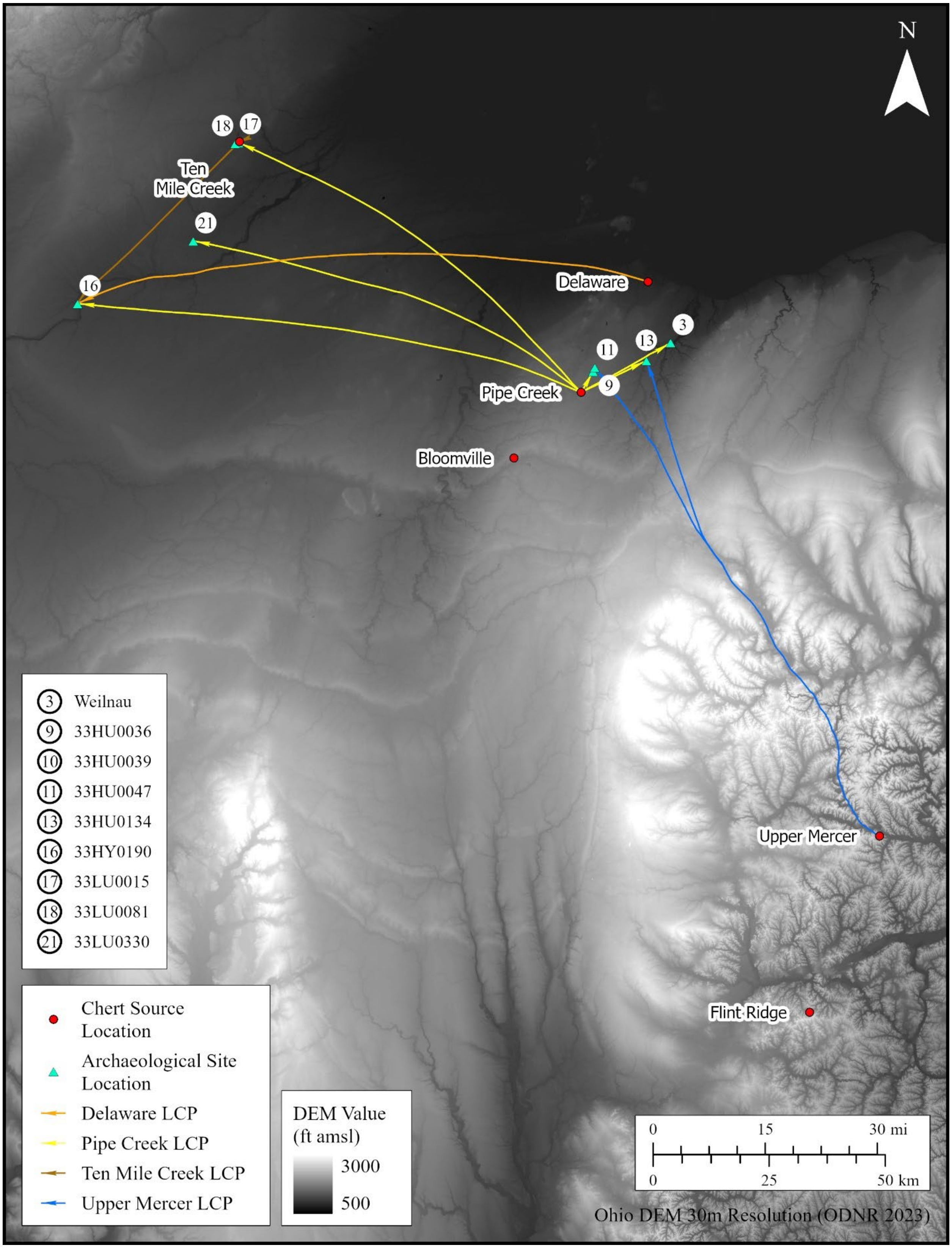
Table 6: Small Bifurcate Horizon Projectile Point Data

Map Key #	Site Name	County	Reference	Local Chert Types				Non-Local Chert Types		
				Bloomville	Delaware	Pipe Creek	Ten Mile Creek	Flint Ridge	Upper Mercer	Total
3	33ER409 (Weilnau)	Erie	Abel 1994; Stothers 1996	0	0	5	0	0	0	5
9	33HU0036 (Werner Quarry)	Huron	Personal analysis, Chidester et al. 2021a, 2021b	0	0	1	0	0	0	1
11	33HU0047 (Lepley Quarry)	Huron	Personal analysis, Chidester et al. 2021a, 2021b	0	0	0	0	0	1	1
13	33HU0134 (F-3 Site)	Huron	Stothers 1996	0	0	1	0	0	2	3
16	33HY0190 (Palmer Site)	Henry	Stothers 1996	0	1	2	2	0	0	5
17	33LU0015 (Ten Mile Creek)	Lucas	Stothers 1996	0	0	1	3	0	0	4
18	33LU0081 (Site Deception)	Lucas	Stothers 1996	0	0	0	1	0	0	1
21	33LU0330 (Heurman)	Lucas	Stothers 1996	0	0	1	0	0	0	1
Total				0	1	11	6	0	3	**21**
				18				**3**		

Table 7: Small Bifurcate Horizon Least Cost Path Results

Chert Source Location	Destination Site	LCP Distance (km)	LCP Distance (mi)
Delaware	**33HY0190**	**124.77**	**77.53**
Pipe Creek	33LU0081	92.37	57.39
	33LU0030	90.78	56.41
	33HY0190	**110.73**	**68.80**
	Weilnau	22.04	13.69
	33HU0134	15.63	9.71
	33HU0036	5.20	3.23
Ten Mile Creek	33LU0015	0.34	0.21
	33LU0081	1.05	0.65
	33HY0190	**49.42**	**30.71**
Upper Mercer	33HU0134	116.96	72.67
	33HU0047	**120.56**	**74.91**

Figure 18: Small Bifurcate Horizon Least Cost Path Results



5.5 Summary of Results

The chert identification analysis of the Early Archaic Pipe Creek quarry points resulted in the identification of 17 Kirk Horizon tools, one Large Bifurcate Horizon tool, and two Small Bifurcate Horizon tools. The majority of the Kirk Horizon tools (80.9%) were manufactured from local chert types. The Large Bifurcate tool was manufactured from the non-local Upper Mercer chert variety (100%). One Small Bifurcate Horizon tool was manufactured with a local chert type while the other was manufactured with a non-local chert type (50.0%). A compilation of these results with regional data lead to similar observations. Two-hundred and thirty-five Kirk Horizon tools, 284 Large Bifurcate Horizon tools, and 21 Small Bifurcate tools were included in the examination. The majority of the Kirk Horizon and Small Bifurcate Horizon tools (95.7% and 85.7%, respectively) were manufactured from local materials while the majority (91.9%) of the Large Bifurcate horizon tools were manufactured from non-local materials.

An LCP analysis was conducted between the chert source location and the projectile point find spots for each horizon. The resulting LCPs suggested the extent of each chert type's lithic supply zone. During the Kirk Horizon, Bloomville chert extended 33-km (21-mi); Delaware chert extended 90-km (56-mi); Pipe Creek chert extended 104-km (65-km); Ten Mile Creek chert extended 50-km (31-mi); Flint Ridge extended 200-km (140-mi); and Upper Mercer chert extended 218-km [135-mi]). During the Large Bifurcate Horizon, Delaware chert extended 94-km (58-mi); Pipe Creek chert extended 110-km (69-mi); Ten Mile Creek chert extended 24-km (15-mi); Flint Ridge chert extended 158-km (98-mi); and Upper Mercer extended 212-km (132-mi). During the Small Bifurcate Horizon, Delaware chert extended 125-km (78-mi); Pipe Creek extended 111-km (69-mi); Ten Mile Creek chert extended 50-km (31-mi); and Upper Mercer chert extended 120-km (75-mi) (Table 8). The following chapter presents an interpretation of these results.

Table 8: Longest LCP Extents by Horizon

Chert Type	Longest LCP Extents		
	Kirk Horizon	**Large Bifurcate Horizon**	**Small Bifurcate Horizon**
Bloomville	33-km (21-mi)	Null	Null
Delaware	90-km (56-mi)	94-km (58-mi)	125-km (78-mi)
Pipe Creek	104-km (65-mi)	110-km (69-mi)	111-km (69-mi)
Ten Mile Creek	50-km (31-mi)	24-km (15-mi)	50-km (31-mi)
Flint Ridge	200-km (140-mi)	158-km (98-mi)	Null
Upper Mercer	218-km (135-mi)	212-km (132-mi)	120-km (75-mi)

Chapter 6: Analysis

The analyses conducted in this thesis attempted to investigate changes in chert preference and lithic supply zone extents throughout the Early Archaic Period. The purpose of the artifact analysis and collection of regional projectile point data was to determine if non-local cherts (Flint Ridge and Upper Mercer cherts) were preferred over more local cherts (Bloomville, Delaware, Pipe Creek, and Ten Mile Creek cherts) throughout all Early Archaic horizons in northwestern Ohio. An LCP analysis was conducted with the newly aggregated regional data to gain a better understanding of lithic supply zones and to revisit Stothers (1996) hypothesized Early Archaic band territories. The results of these analyses provided insight to both of these topics.

6.1 Chert Preferences and Lithic Supply Zones during the Kirk Horizon

Starting with chert sourcing preferences, a few observations were made. The data showed that non-local chert types did not dominate the Kirk Horizon projectile point assemblage as Stothers (1996) previously suggested. In fact, the majority of the assemblage consisted of local chert types (95.7%).

It is important to note that, while Stothers claimed that the Kirk Horizon projectile point data he collected indicated an almost complete dependence on non-local Upper Mercer and Flint Ridge cherts, Chidester (2011) took notice of a discrepancy between this claim and the data Stothers presented. Stothers' table describing Kirk Horizon projectile points discovered in the lower Maumee Valley (Stothers 1996: 199; Table 2) lists 67 points manufactured from Upper Mercer chert, 19 manufactured from Flint Ridge, 17 manufactured from Delaware, 21 manufactured from Pipe Creek, and 43 manufactured from Ten Mile Creek. Out of these points (n=167), only around half of the assemblage is comprised of non-local cherts (n=86, 51.5%). This data does not indicate an overwhelming predominance of non-local cherts in northwestern Ohio. Therefore, the regional data collected for this study is not in opposition to Stothers' original dataset, but the interpretation of this data differs.

Overall, the regional data demonstrates that, while Upper Mercer chert (non-local) was not exclusively preferred, it was commonly utilized in northwestern Ohio during the Kirk Horizon. This evokes a question about whether the resource was procured through direct procurement (traveling to the source) or indirect procurement (economic or social exchange). This discussion goes beyond the scope of this study, and therefore, both possibilities will be considered during the interpretation of results. The regional data also demonstrates that the Archaic peoples manufacturing Kirk Horizon tools were utilizing a variety of local chert sources within northwestern Ohio. Past studies have provided evidence that the utilization of local chert types for tool manufacture indicates reduced mobility and more permanent occupations of the area (see Chapter 3, Section 2). If this is correct, then does the regional data point to occupational continuity in the Kirk Horizon from the preceding Paleoindian Period? Do these findings dispute Stothers' theory on the displacement of peoples in northern Ohio during the Early Archaic Kirk Horizon? A look at the spatial analysis may provide more insight to these questions.

The LCP analysis conducted with Kirk Horizon projectile point data displays possible movement patterns between northwestern Ohio's chert source locations. Multiple tools manufactured from Bloomville chert were found at the Pipe Creek quarry sites 33-km (21-mi) north of the Bloomville chert outcropping. Tools manufactured from Pipe Creek chert were found north of their source location as well as 104-km (64-mi) west towards the Ten Mile Creek chert outcropping. This lithic supply zone is much larger than the previously assumed 48-km (30-mi) utilization radius. Tools manufactured from Delaware chert were found 27-km (17-mi) south towards the Pipe Creek chert outcropping and 90-km (56-mi) west towards the Ten Mile Creek chert outcropping. This lithic supply zone is also much larger than its previously assumed 48-64-km (30-40-mi) utilization radius for Pipe Creek (see DeRegnaucourt and Georgiady 1998). Projectile points manufactured from Ten Mile Creek chert were all discovered within 50-km (31-mi) of their source outcropping. Tools manufactured from Flint Ridge and Upper Mercer cherts were discovered at sites near the Pipe Creek and Ten Mile Creek chert outcroppings as far as 218-km (135-mi) northwards. The LCP for these tools suggests that the most energetically efficient path a traveler could take traveling north from the Upper Mercer outcropping is a path that follows the Mohican River watershed. This path passes between the Pipe Creek chert and Delaware chert outcroppings. The lithic supply zones for each of the chert sources match the ranges for Stothers' hypothesized band territories (see Chapter 3, Figure 10).

If Early Archaic bands procured chert materials directly from these chert source locations, the results of the LCP analysis could imply logistical travel between the chert outcroppings during seasonal migrations as opposed to trade. During seasonal rounds, it is likely Archaic bands would discard their worn-out tools at quarry sites and then replenish their toolkits (see Gramly 1980; Lepper et al. 2001, Mullet 2009; and Seeman 1994). This type of seasonal mobility would result in diverse raw material use from the different chert source locations within the region. This hypothesis is supported by the evidence of worn-out tools made of non-local cherts found at the Pipe Creek quarry sites and the diversity of chert types represented by Kirk Horizon projectile points.

In summary, peoples manufacturing tools during the Kirk Horizon (ca. 9500-8900 B.P.) were familiar with and utilizing a variety of chert sources within northwestern Ohio. These peoples may have been traveling directly to the Upper Mercer chert outcropping as part of a seasonal round.

If traveling north from the Upper Mercer chert outcropping, it would have been energetically efficient for the Archaic bands to travel along the Mohican River tributaries towards the Pipe Creek and Delaware quarries on their way into southwestern Ontario or towards the Ten Mile Creek outcropping on their way north.

6.2 Chert Preferences and Lithic Supply Zones during the Large Bifurcate Horizon

In stark contrast from the Kirk Horizon assemblage, the Large Bifurcate Horizon assemblage almost entirely consisted of Upper Mercer points (91.9%). Pipe Creek chert was secondary in occurrence, forming 3.9% of the assemblage, and Flint Ridge chert was tertiary, forming 2.8% of the assemblage. These three chert types are considered higher-quality materials. The lower-quality cherts, Delaware and Ten Mile Creek, each represented less than 1.0% of the assemblage. No Large Bifurcate points manufactured from Bloomville have been discovered. This data demonstrates that higher-quality cherts, namely Upper Mercer, were purposefully sought-after by Large Bifurcate tool making populations.

The Large Bifurcate Horizon assemblage was the largest and most widely distributed of the Early Archaic tool assemblages. The farthest extent of the Upper Mercer LCPs was 212-km (132-mi) northwest from the source location. If Upper Mercer was procured directly from the source, the extents of the Upper Mercer LCPs complement Bowen (1994) and Stothers' (1996) proposed territorial band ranges. These ranges were estimated to span between 150 to 250-km (93 to 155-mi). The LCP extents for Flint Ridge, Pipe Creek, and Delaware cherts were similar to what was observed during the Kirk Horizon. The extent of the Ten Mile Creek chert LCP (24-km [15-mi]) is shorter in comparison to what was observed during the Kirk Horizon (49-km [31-mi]). This was the only lithic supply zone to decrease in size by the Large Bifurcate Horizon. While it is possible this change resulted from an insubstantial sample population, it may also indicate a disinclination towards poorer-quality chert types during this period.

The regional projectile point data and LCP analysis results suggest that the Archaic peoples manufacturing Large Bifurcate Horizon tools (ca. 9,000 to 8,500 B.P.) had a strong preference for non-local high-quality Upper Mercer chert and may have been willing to travel extensively to procure it.

Stothers suggested that the presence of non-local chert types in Early Archaic toolkits could be interpreted in three ways: (1) the transfer of materials through mating networks; (2) the result of gift-giving to build socio-political alliances; (3) territorial band movements. Yet, when a non-local material dominates the majority of toolkits from a variety of isolated sites dispersed across a landscape, a direct procurement of the resource through territorial band movements can be assumed (1996:204). It was this reasoning that led Stothers to conclude there was a population influx of hunter-gatherer bands from southern Ohio to northwestern Ohio during the Early Archaic. The results of the Large Bifurcate Horizon analysis raise many questions. While the presence of non-local chert types in artifact assemblages is often interpreted as evidence for mobile populations, does the dominance of Upper Mercer chert in Large Bifurcate Horizon toolkits necessarily indicate a colonization event? Although the analysis results support the popularity of Upper Mercer chert during the Large Bifurcate Horizon, the same popularity was not observed during the Kirk Horizon. Is it only coincidental that the increase in the preference for Upper Mercer chert coincides with the distribution of Large Bifurcate tools across northwestern Ohio? It has been debated previously if the Kirk Horizon and Large Bifurcate Horizon represent different cultural manifestations (see Purtill 2009). If a change in tool form occurred synchronically with a change in chert preference, is that evidence of cultural identity? If the answer to this last question is yes, then a demographic change, such as a colonization event, occurring in northwestern Ohio during the Large Bifurcate Horizon could be argued for.

6.3 Chert Preferences and Lithic Supply Zones during the Small Bifurcate Horizon

The Small Bifurcate Horizon (ca. 8,500 to 7,800 B.P.) projectile point data indicates a return to the preference for local cherts which make up 85.7% of the assemblage. Pipe Creek chert was the most represented of the chert types (n=11), followed by Ten Mile Creek (n=6), and Upper Mercer (n=3). Bloomville and Flint Ridge cherts were not present in this assemblage.

The resulting lengths of the LCPs for Pipe Creek and Ten Mile Creek cherts remained the same as observed in the Kirk Horizon analysis. Discrepancies were observed in the LCP results for Delaware and Upper Mercer cherts. The lithic supply zone for Delaware chert extended 125-km (78-mi) westward, a 35-km (22-mi) increase from the Kirk and Large Bifurcate Horizon results. However, it should be noted that these results were based on the location of a singular Delaware point discovered at the Palmer site in Henry County and may be statistically insignificant. The lithic supply zone for Upper Mercer chert extended 121-km (75-mi) northwest, a 91-km (56-mi) decrease from the Kirk and Large Bifurcate Horizon results. If these materials were procured directly, the changes in the lithic supply zone extents may reflect more familiarity with local resources or a rise in the dependence on local cherts and decrease in band mobility during this period.

As previously stated, the utilization of local chert types for tool manufacture is typically interpreted as evidence for reduced mobility and more permanent occupations of an area. This result is not unexpected for what is currently understood about this horizon. It is generally believed that peoples during the later part of the Early Archaic were settling into their environments (see Purtill 2009, Stothers 1996). Yet, a few questions regarding this data remain.

If Archaic bands were reducing their mobility during this horizon, then what does the presence of Upper Mercer chert in their toolkits signify in regards to the procurement of the material? Had systems of exchange been established by this time or were bands still undertaking seasonal journeys to the chert outcropping in central Ohio? Or, was Upper Mercer being sourced from eroded river bed cobbles in more northern counties? While answering these questions is beyond the capacity of this study, they are important considerations for future research.

Overall, the results of this study imply that lithic procurement during the Early Archaic Period was not as consistent across the Kirk and Large Bifurcate Horizons as formerly surmised. The peoples manufacturing Kirk Horizon tools (ca. 9,500 to 8,900 B.P.) were utilizing a variety of chert sources local to northwestern Ohio, likely as part of an embedded procurement system during their seasonal rounds. An analysis of LCPs between chert source locations and artifact findspots during this horizon demonstrated that the lithic supply zones for Pipe Creek (104-km [65-mi]) and Delaware (90-km [56-mi]) cherts were much larger than their previously assumed 50 to 65-km (30 to 40-mi) radius. In contrast, the peoples manufacturing Large Bifurcate tools (ca. 9,000 to 8,500 B.P.) heavily relied on Upper Mercer chert. The lithic supply zone for this chert is estimated to span between 150 to 250-km (93 to 155-mi). It is possible that the peoples manufacturing Large Bifurcate tools migrated from southeastern to northwestern Ohio during this horizon. The subsequent Small Bifurcate Horizon (ca. 8,500 to 7,800 B.P.) saw a return to the utilization of local cherts and possible decrease in mobility ranges. While these findings provided new hypotheses regarding Early Archaic chert preferences, lithic supply zone extents, and band mobility, they also pose further questions. Future research, encompassing a larger breadth of data than what was included in this study, might be able to address these questions.

Chapter 7: Conclusion

The catalyst for this study was an interest in the regional implications of the chert types identified from Early Archaic tools discovered at five recently discovered quarry locales in northwestern Ohio. The scarcity of Upper Mercer chert in these Early Archaic assemblages challenged existing theories on population movements within the region. The goal of this thesis was to comprehend how changes in lithic supply zones and preferences for local and non-local lithic material relate to the migrations of Early Archaic people in northwestern Ohio. Three corollary questions were posed to explore specific aspects of the primary research question:

1) How did chert preferences differ throughout the three Early Archaic horizons in northwestern Ohio?

2) What were the Least Cost Path (LCP) extents of Early Archaic lithic supply zones in northwestern Ohio?

3) Will an analysis of new and existing regional projectile point data support the existing theory of Early Archaic population movements in northwestern Ohio?

To answer these questions, a detailed chert-sourcing analysis was conducted on the Early Archaic artifacts from five quarry sites. The results of this analysis were then compiled with additional regional data to gain a more comprehensive understanding of chert utilization preferences. Then, an LCP analysis using ESRI's GIS Pro software was conducted between chert source locations and archaeological site locations. The results of both analyses were compared to the previous theories to distinguish any discrepancies between the available data. These efforts generated the following conclusions:

1) How did chert preferences differ throughout the three Early Archaic horizons in northwestern Ohio?

The results of this thesis demonstrate that chert preferences throughout the Early Archaic horizons of northwestern Ohio were not homogenous. Chert preferences and supply zone extents differed across the three horizons of this period, possibly in response to environmental or demographic fluctuations. The peoples manufacturing tools during the Kirk Horizon were utilizing a variety of local chert sources in contrast to the peoples manufacturing tools during the Large Bifurcate Horizon, who heavily relied on Upper Mercer chert. The peoples manufacturing tools during the Small Bifurcate Horizon returned to the utilization of local cherts, possibly resulting from a decrease in mobility ranges. Interestingly, the data shows that while the maximum distances for Delaware, Pipe Creek, and Upper Mercer, were fairly consistent across each of the horizons, there was a difference in utilization. This could indicate chert preference may have been influenced by factors other than distance.

2) What were the Least Cost Path (LCP) extents of Early Archaic lithic supply zones in northwestern Ohio?

The LCP analysis was successful in displaying energetically efficient travel routes between Ohio's chert sources. These routes (Figures 16-18) are not proposed as historically-accurate travel routes but as hypothesized movement patterns. One route started at the Upper Mercer and Flint Ridge chert outcroppings in Coshocton and Licking Counties, Ohio. This route traveled northwest following the Mohican River watershed towards the Pipe Creek and Delaware chert outcroppings. If traveling into Michigan, it would have been energetically efficient for the hunter-gatherer bands at the Pipe Creek or Delaware quarries to then travel northwest through the low-lying Lake Plains towards the Ten Mile Creek chert outcropping in Lucas County, Ohio. A second path starting at the Flint Ridge chert outcropping, traveled northwest through low-lying terrain towards the Ten Mile Creek chert source location. Energetically efficient paths that traveled southwards were observed from the Ten Mile Creek and Delaware chert sources. Tools manufactured from Ten Mile Creek chert were discovered south of the source location along the Maumee River watershed. Tools manufactured from Delaware chert were discovered at the Pipe Creek quarry sites and near the Ten Mile Creek chert outcropping. The use of Bloomville chert was tightly localized and only found north near the Pipe Creek quarry sites. These hypothesized movement patterns are in agreement with Stothers' (1996) previously suggested band territories (see Figure 4). These movement patterns likely reflect the embedded procurement of these materials during seasonal band migrations.

The results of this analysis also expanded the known lithic supply zone extents for both Pipe Creek and Delaware cherts. The lithic supply zones for Pipe Creek (104-km [65-mi]) and Delaware (90-km [56-mi]) cherts were much larger than their previously assumed 50 to 65-km (30 to 40-mi) radius. Another result of the LCP analysis was the recognition of the reduction or expansion of lithic supply zones across the Early Archaic horizons. During the Large Bifurcate Horizon, the Ten Mile Creek chert lithic supply zone was 26-km (16-mi) shorter than what was observed during the Kirk Horizon. During the Small Bifurcate Horizon, the lithic supply zone for Delaware chert increased 35-km (22-mi) from what was observed in the Kirk and Large Bifurcate Horizons. Also, the lithic supply zone for Upper Mercer decreased 91-km (56-mi) from what was observed in the Kirk and Large Bifurcate Horizons. These changes in lithic supply zone extents likely reflect the increase or decrease in utilization of poorer-quality chert types during these periods. Smaller extents may also represent lower mobility as a result of population growth.

3) Will an analysis of new and existing regional projectile point data support the existing theory of Early Archaic population movements in northwestern Ohio?

The results of this thesis negate the previous claim that Kirk Horizon tool assemblages consist almost entirely of Upper Mercer chert, but support the claim that Large Bifurcate tool assemblages consist almost entirely of Upper Mercer chert (Bowen 1994; Stothers 1996). With further evidence, these findings could support the occurrence of a colonization event, as proposed by Stothers (1996), during the Large Bifurcate Horizon. Although, the validity of the colonization theory is still debatable. While it is clear that the Archaic peoples manufacturing Large Bifurcate Horizon tools had a strong preference for non-local high-quality Upper Mercer chert, not enough evidence has been presented to determine whether the wide distribution of these Upper Mercer tools reflects permanent population movements (i.e., colonization), increase in mobility ranges, trade, or social exchange.

One of the criticisms suggested by the existing research for this topic is that a singular normative framework regarding Archaic band mobility has been unquestionably applied to all regions of the state (see Purtill 2009). It would appear that the assumption that the Early Archaic peoples of Ohio were highly mobile and only utilized high-quality, often southern-based, chert types does not apply to northwestern Ohio's Kirk Horizon assemblages. In fact, it is likely this population was familiar with the region's available chert sources and integrated quarry visits into their seasonal hunting rounds. However, it is unclear whether this familiarity with regional resources is equivalent to settling into the area because of the lack of identifiable Early Archaic habitation sites within the region.

The answers to the three corollary questions ultimately provide an answer to the primary research question: *How do changes in lithic supply zones and preferences for local and non-local lithic material relate to the migrations of Early Archaic people in northwestern Ohio?*

Changes in lithic supply zones and lithic preferences are potentially related to changes in mobility ranges or seasonal migrations. The accessibility of specific chert types was more than likely influenced by environmental, social, or political factors, such as territoriality. The ability to easily replenish lithic toolkits would have been essential during seasonal migrations. Therefore, a significant change in chert preference, likely indicates a change in quarry access. The results of this study demonstrated that while the first horizon of the Early Archaic period saw a variety in northwestern Ohio chert utilization, the second horizon saw a strong preference for a non-local lithic material from central Ohio. While the reason for this significant change was not answered by this research, the results of this thesis made evident the toolkit replenishing relationship between chert source locations, expanded the lithic supply zones of Pipe Creek and Delaware cherts, and proposed broad lithic procurement travel routes between central and northwestern Ohio. This thesis also refined Stothers' (1996) colonization hypothesis, in that if a colonization event occurred, it most likely occurred during the Large Bifurcate horizon.

The conclusions resulting from this thesis are not without limitations. The projectile point data included in this study originated from surface finds lacking stratigraphic integrity or absolute dating evaluations. The temporal affiliations of the artifacts were assumed based on well-established typological identifications. The temporal affiliations of small Kirk Horizon tools such as Palmer Corner-notched and Nettling projectile points have been disputed because of their similarity with Amos projectile points. Some researchers believe these points may actually date closer to the Middle Archaic Period (Bowen 1992, personal communication 2024). However, no peer-reviewed studies are currently available to substantiate this claim. Future research that includes stratigraphic or absolute dating techniques at archaeological sites yielding Early Archaic projectile points within the region would improve the temporal integrity of this data.

Another constraint the study faced was perfect accuracy in chert identification. As previously stated, there are some instances in which varieties of chert are so similar they cannot be identified with absolute certainty without undergoing microscopic or chemical analysis. Chert typologies are also not stagnant. Some chert variations have only been recently identified or recognized. For instance, Pipe Creek chert, which was identified in 1976, has not yet been intensively studied and is not widely known in other regions of Ohio. In fact, it is possible that other researchers have been mistaking certain variations of Pipe Creek chert as Delaware, Flint Ridge, and Upper Mercer cherts (Stothers and Rutter 1978) (Figure 19). Most of the collections included in the projectile point dataset were not available for visible examination. The author assumed the chert identifications published by other researchers were correct. A re-evaluation of existing collections and future research in the microscopic or chemical compositions of Ohio cherts would address these issues.

Figure 19: [L-R]: Pipe Creek Chert Kirk Corner-notched Point (33HU0849: Object 3349.02); Upper Mercer Chert Decatur Point (33HU0048; Object 2871.01), original photos in the possession of the author.

While the limitations of LCP analysis were discussed in detail in Chapter 4, it is important to note that an inclusion of more extensive environmental data in the creation of the cost surface would improve the accuracy of the results. If higher resolution DEMs and Archaic Period environmental reconstruction layers become available in the future, the results of this study should be revisited.

Lastly, the parameters of the study restricted the ability of the results to address broad-reaching questions such as: Was there occupational continuity between the Paleoindian Period and Early Archaic Kirk Horizon in northwestern Ohio? Do stylistic concepts originate at quarry sites? Does the increase in the preference for Upper Mercer chert coincide with the distribution of Large Bifurcate tools across all regions of Ohio? Does the appearance of Large Bifurcate tools in northwestern Ohio represent a colonization event? Had formal systems of exchange been established by the later Early Archaic? A larger breadth of data which includes Early Archaic habitation sites with stratigraphic integrity, a complete overview of Large Bifurcate tools in Ohio, and conclusive evidence regarding procurement strategies compiled throughout the state would address these significant inquiries. This thesis demonstrated that the combination of archaeological data synthesis from large-scale Phase I cultural resource management studies and innovative GIS analysis can be used to address hypotheses about past lifeways. It also demonstrated that data resulting from Phase I studies can yield important results. It is the author's hope that these methods will continue to advance and contribute to a better understanding of the human past.

Appendix A: Artifact Photos

Figure A 1: Kirk Corner-notched Hafted Scrapers [L-R]; [Upper] Bloomville (Objects 1153.01, 1155.01, 1156.01, 3353.01, 3355.01), [Lower] Delaware (Object 1164.01), Upper Mercer (Objects 1146.01, 1157.01). Original photo in possession of the author.

Figure A 2: Kirk Corner-notched Projectile Points [L-R]; [Upper] Bloomville (Objects 1657.01, 3361.01), [Middle] Delaware (3364.01, 3354.01, 2546.01, 3351.01), [Lower] Pipe Creek (Objects 3360.01, 3349.02). Original photo in possession of the author.

Figure A 3: Decatur Projectile Points [L-R]; Bloomville (Object 2871.01), Upper Mercer (Object 2524.01). Palmer Corner-notched Projectile Points [L-R]; Bloomville (Objects 3053.01, 2873.01), Flint Ridge (Object 3051.01). Original photo in possession of the author.

Figure A 4: St. Albans Projectile Point; Pipe Creek (Object 3049.01). Lake Erie Bifurcated Projectile Points [L-R]; Pipe Creek (Object 3052.01), Upper Mercer (Object 2872.01). Original photo in possession of the author.

Bibliography

Abel, T. J.

1994 An Early Archaic Habitation Structure at the Weilnau Site, North-Central Ohio. In *The First Discovery of America: Archaeological Evidence of the Early Inhabitants of the Ohio Area*, edited by William S. Dancey, pp. 61-76. Ohio Archaeological Council, Columbus.

Andrefsky, W.

2008 The Analysis of Stone Tool Procurement, Production, and Maintenance. *Journal of Archaeological Research* 17:65-103.

2006 *Lithics: Macroscopic Approaches to Analysis.* Cambridge Manuals in Archaeology, 2nd Edition. Cambridge University Press.

Binford, L. R.

1979 Organization and Formation Processes: Looking at Curated Technologies. *Journal of Anthropological Research* 35(3):255-273.

1980 Willow Smoke and Dogs' Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* 45(1): 4–20.

Blank, J. E.

1970 The Ohio Archaic: A Study in Culture History. Ph.D. dissertation, Department of Anthropology, University of Massachusetts, Amherst.

Bowen, J. E.

1990 Early Archaic of the Lower Sandusky River Drainage. *Ohio Archaeologist* 40(3):32-36.

1991 The Early Archaic Savannah Lakes Phase of North-Central Ohio. *Ohio Archaeologist* 41(1):24-29.

1992 Early/Middle Archaic Occupations of the Sandusky River, Green Creek, and North Ridge Survey Tracts in Sandusky County, Ohio. *Ohio Archaeologist* 42(3):20-25.

1994 *Upper Mercer Flint Large Bifurcates of the Ohio Region*. Sandusky Valley Chapter, Archaeological Society of Ohio, Upper Sandusky, Ohio.

Branting, S.

2012 Seven Solutions for Seven Problems with Least Cost Pathways. *In Least Cost Analysis of Social Landscapes*, edited by Devin A. White and Sarah L. Surface-Evans, pp. 209-224. The University of Utah Press, Salt Lake City.

Chidester, R. C.

2011 Re-Evaluating Colonization and Cultural Change During the Early Archaic Period in Northwestern Ohio. *Archaeology of Eastern North America* 39:109-130.

Chidester, R. C., K. J. Hayfield, A. R. Darkow, D. Hershberger, A. Zissis and M. Bell
2021a *Phase I Archaeological Survey for the Emerson Creek Wind Project in Groton and Oxford Townships, Erie County, and Lyme, Norwich, Ridgefield, and Sherman Townships, Huron County, Ohio*. Report submitted to Firelands Wind, LLC, Charlottesville, VA by The Mannik & Smith Group, Inc., Maumee, OH.

Chidester, R. C., E. L. Hickle, K. J. Hayfield, D. Julien, M. Bell, and A. R. Darkow
2021b *Addendum Report: Additional Phase I Archaeological Survey for the Emerson Creek Wind Project in Groton and Oxford Townships, Erie County, and Lyme, Norwich, Ridgefield, and Sherman Townships, Huron County, Ohio.* Report submitted to Firelands Wind, LLC, Charlottesville, VA by The Mannik & Smith Group, Inc., Maumee, OH.

Chidester, R. C., A. Zissis, K. J. Hayfield, M. Bell, and A. R. Darkow
2022 *Phase II Archaeological Evaluations of Five Pre-Contact Archaeological Sites (33ER0086, 33ER0696, 33HU0048, 33HU0678, and 33HU0831) for the Emerson Creek Wind Project, Erie and Huron Counties, Ohio.* Report submitted to Firelands Wind, LLC, Charlottesville, VA by The Mannik & Smith Group, Inc., Maumee, OH.

DeRegnaucourt, T. and J. Georgiady
1998 *Prehistoric Chert Types of the Midwest. Occasional Monograph No. 7.* Upper Miami Valley Archaeological Research Museum, Arcanum, Ohio.

Dowd, A. S.
2013 George H. Odell's Contributions to Lithic Quarry and Raw Material Procurement Research. *North American Archaeologist* 34(4):307-321.

Ebert, D.
2004 Applications of Archaeological GIS. *Canadian Journal of Archaeology* 28(2):319-341.

Elston, R. G.
2013 Selection, Planning, and Convenience in Lithic Procurement. *North American Archaeologist* 34(4):433-450.

Environmental Systems Research Institute, Inc. (ESRI)
2023 Least Cost Path (AllSource). Electronic document https://pro.arcgis.com/en/pro-app/latest/tool-reference/intelligence/least-cost-path.htm, accessed February 28, 2024.

Forsyth, J. L.
1973 Late Glacial and Postglacial History of Western Lake Erie. *The Compass of Sigma Gamma Epsilon* 51(1):16-26.

Geistweit, B. A.
1970 Archaic Manifestations in Ohio and the Ohio Valley. Master's thesis, Department of Anthropology, the Ohio State University, Columbus.

Goodyear, A. C.
1979 *A Hypothesis for the Use of Cryptocrystalline Raw Materials Among Paleo-Indian Groups of North America.* University of South Carolina Research Manuscript Series 127.

Gramly, R. M.
1980 Raw Materials Source Areas and "Curated" Tool Assemblages. *American Antiquity* 45(4): 823-833.

Hickle, E. L., R. C. Chidester, M. Bell, A. Zissis, A. R. Darkow, and K. J. Hayfield
2023 *Third Addendum Report: Additional Phase I Archaeological Survey for the Emerson Creek Wind Project in Groton Township, Erie County, and Lyme, Norwich, and Sherman Townships, Huron County, Ohio.* Report submitted to Firelands Wind, LLC, Charlottesville, VA by The Mannik & Smith Group, Inc., Maumee, OH.

Holcombe, T. L., L. A. Taylor, D. F. Reid, J. S. Warren, P. A. Vincent, and C. E. Herdendorf
2003 Revised Lake Erie Postglacial Lake Level History Based on New Detailed Bathymetry. *Journal of Great Lakes Research* 29:681-704.

Jeske, R. J.
1992 Energetic Efficiency and Lithic Technology: An Upper Mississippian Example. *American Antiquity* 57(3):467-481.

Justice, N. D.
1987 *Stone Age Spear and Arrowpoints of the Midcontinental and Eastern United States*. Indiana University Press, Bloomington.

Kagelmacher, M. L.
2000 Ohio Cherts of Archaeological Interest: A Macroscopic and Petrographic Examination and Comparison. Master's thesis, Department of Anthropology, Kent State University, Ohio.

Keener, C. S., K. Butterworth, and C. L. Reustle
2008 Cultural Resource Management and the Analysis of Land Use Patterns of the Archaic in North-Central Ohio. In *Transitions: Archaic and Early Woodland Research in the Ohio County*, edited by M. P. Otto and B. G. Redmond, pp. 29-40. Ohio University Press, Athens.

Lepper, B.T, R. W. Yerkes and W. H. Pickard
2001 Prehistoric Flint Procurement Strategies at Flint Ridge, Licking County, Ohio. *Midcontinental Journal of Archaeology* 26(1):53-78.

Leudtke, B. E.
1979 The Identification of Sources of Chert Artifacts. *American Antiquity* 44(4):744-757.

Moffett, R.
1949 The Raisch-Smith Site, an Early Indian Occupation in Preble County, Ohio. *Ohio Archaeological and Historical Quarterly* 58:428-441.

Mullett, A. N.
2009 *Paleoindian Mobility Ranges Predicted by the Distribution of Projectile Points Made of Upper Mercer and Flint Ridge Flint.* Master's thesis, Department of Anthropology, Kent State University, Kent, Ohio.

Ohio Department of Natural Resources (ODNR)
2006 Geographic Regions of Ohio Map. Electronic document https://ohiodnr.gov/static/documents/geology/MiscMap_OhioPhysiographicRegions_1998.pdf, accessed March 8, 2024.
2023 GIS Metadata Downloads. Electronic database https://ohiodnr.gov/business-and-industry/services-to-business-industry/data-records/metadata-downloads, accessed February 28, 2024.

Pratt, G. M.
1981 The Western Basin Tradition: Changing Settlement Subsistence Adaptation in the Western Lake Erie Basin Region. Ph.D. dissertation, Department of Anthropology, Case Western Reserve University, Cleveland.

Prufer, O. H. and D. A. Long
1986 *The Archaic of Northeastern Ohio*. Kent State Research Papers in Archaeology No. 6., Kent State University, Ohio.

Purtill, M. P.
2009 The Ohio Archaic: A Review. In *Archaic Societies: Diversity and Complexity across the Midcontinent,* edited by T. E. Emerson, pp. 565-600. Albany, New York: State University of New York Press.

Rissetto, J. D.
2012 Using Least Cost Path Analysis to Reinterpret Late Upper Paleolithic Hunter-Gatherer Procurement Zones in Northern Spain. In *Least Cost Path Analysis of Social Landscapes* edited by Devin A. White and Sarah L. Surface-Evans, pp. 11-31. The University of Utah Press, Salt Lake City.

Seeman, M. F.
1994 Intercluster Lithic Patterning at Nobles Pond: A Case for "Disembedded" Procurement among Early Paleoindian Societies. *American Antiquity* 59(2):273-288.

Shane, L. C. K.
1994 Intensity and Rate of Vegetation and Climatic Change in the Ohio Region between 14,000 and 9,000 14C YBP. In *The First Discovery of America: Archaeological Evidence of the Early Inhabitants of the Ohio Area*, edited by William S. Dancey, pp. 7-21. The Ohio Archaeological Council, Columbus.

Sparks, J. M.
2013 Procurement and Movement of Lithic Raw Materials in Shawnee Lookout Park, Ohio. *North American Archaeologist* 34(2)111-136.

Stothers, D. M.
1996 Resource Procurement and Band Territories: A Model for the Lower Great Lakes PaleoIndian and Early Archaic Settlement System. *Archaeology of Eastern North America* 24:173-216.

Stothers, D. M., T. J. Abel, and A. M. Schneider
2001 Archaic Perspectives in the Western Lake Erie Basin. In *Archaic Transitions in Ohio and Kentucky Prehistory*, edited by Olaf H. Prufer, Sara E. Pedde, and Richard S. Meindl, pp. 233-289. The Kent State University Press, Kent, Ohio.

Stothers, D. M. and W. Rutter
1978 Pipe Creek Chert: Newly Discovered Aboriginal Quarry Source. *Ohio Archaeologist* 28(3):13.

Stout, W. and R. A. Schoenlaub
1945 *The Occurrence of Flint in Ohio.* Ohio Geological Survey 4th Series Bulletin No. 46, Columbus, Ohio.

Surface-Evans, S. L.
2012 Cost Catchments: A Least Cost Application for Modeling Hunter-Gatherer Land Use. In *Least Cost Analysis of Social Landscapes*, edited by Devin A. White and Sarah L. Surface-Evans, pp. 128-151. The University of Utah Press, Salt Lake City.

Surface-Evans, S. L. and D. A. White
2012 An Introduction to the Least Cost Analysis of Social Landscapes. In *Least Cost Analysis of Social Landscapes*, edited by Devin A. White and Sarah L. Surface-Evans, pp. 1-8. The University of Utah Press, Salt Lake City.

Verhagen, P.
2012 Biting Off More than We Can Chew? The Current and Future Role of Digital Techniques in Landscape Archaeology. In *Landscape Archaeology between Art and Science: From a Multi- to an Interdisciplinary Approach*, edited by S.J. Kluiving and E.B. Guttmann-Bond, pp. 309-320. Amsterdam University Press.

White, D. A. and S. L. Surface-Evans
2012 *Least Cost Analysis of Social Landscapes.* The University of Utah Press, Salt Lake City.

Zipf, G. K.
1949 *Human Behavior and the Principle of Least Effort: An Introduction to Human Ecology.* Addison-Wesley, Cambridge, Massachusetts.