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The Shape Of Diversity: A Morphometric Analysis Of Late Archaic Bifaces From Lamoka Lake

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THE SHAPE OF DIVERSITY: A MORPHOMETRIC ANALYSIS OF LATE ARCHAIC BIFACES FROM LAMOKA LAKE

BY

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THESIS

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Abstract

The general assumption of Late Archaic peoples in the Northeast is that they were one homogeneous culture group, but through the study of Lamoka Lake bifaces found at the Lamoka Lake Site, as well as applying the concepts of community of practice, I have shown that tool shape variation could indicate distinct social groups. Using computer software to digitally outline bifaces I compared the shape of over 400 bifaces from Lamoka Lake and statistically analyzed their morphologies in order to provide material correlates of social diversity. Whether this morphological variation is representative of the conscious or unconscious design choices made by these peoples remains to be seen, however there exists significant statistical difference in biface morphology at this site suggesting distinct social groups. Such a development is significant for Late Archaic research in New York since it directly contradicts the idea that Late Archaic people were one culturally homogenous group.

For My Dad

Acknowledgements

I would like to thank a few different people for whom this project would not have been completed. First, thank you to my advisor Matthew Sanger for making me aware of Lamoka Lake and continuing to be a positive and encouraging voice in my work as well as providing the critical feedback needed to complete this project. Thank you to Nina Versaggi for taking the time to guide my research, help me place my project in its broader regional context, and inspire new understandings of New York prehistory for me.

I would also like to thank the Kathryn Murano and Elizabeth Pietrzykowski at the Rochester Museum and Science Center as well as the RMSC itself without whom I would not have been able to access and research the Lamoka Lake collection. I want to thank Marie-Lorraine "Sissie" Pipes for introducing me to the collection and inspiring some of my thinking about the site.

Finally, I want to thank my entire family for supporting me throughout this project even though they may not have been quite sure what it was all about.

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Chapter 1: Lamoka Lake, Its People, and Its Tools

Since the earliest studies, archaeologists, have looked to the shape of stone tools as a means of determining their function, the constraints caused by raw materials, the skill level of the knapper, and a variety of other factors (Fox 2013; Justice 1987, 2002a, 2002b, Ritchie 1932a, 1971; Thomas 1981). Stone tool morphology has also long been used to identify the presence of distinct social groups in the archaeological record (McKern 1939; Ritchie 1932a, 1971; Thomas 1981; Thulman 2012). In recent years, archaeologists have started to use geometric morphometric software, a technology that can measure and analyze morphological characteristics consistently and accurately (Buchanan and Collard 2010; Bonhomme et al. 2013; Fox 2013; Hammer et al. 2001; Kuhl and Gardina 1982; Rohlf and Marcus 1993; R Core Team 2017; Thulman 2012).

The adoption of these new technologies marks an important step forward as earlier attempts to capture and quantify morphology were subjective and relatively arbitrary. Most early studies focused on "style" as the distinguishing feature of stone tools, particularly hafted bifaces (Fox 2013:9). Because "style" is a subjective category, as new attributes were determined important, archaeologists shifted their points of measurement. This idiosyncratic nature of measurement frustrated attempts to standardize measurements and make methods more objective. When geometric morphometric software was developed in the biological sciences (Rohlf and Marcus 1993) the possibility of standardizing shape categorizations became a reality and allowed

archaeologists (Fox 2013; Lipo et al. 2012, 2016; Thulman 2012), to begin developing increasingly standardized and objective measurements.

Advances in morphometric software also offer an opportunity to measure variability in tool morphology at levels previously unobtainable. Measuring variability can help archaeologists better distinguish how objects change over time and space, through which we can more accurately trace out changing societal patterns, functional demands, and technological innovations in the past. By better measuring morphological variability, we can also investigate the presence of distinct social groups within the archaeological record. Typically artisans and tool-makers learn their crafts through apprenticeship and mimicking the actions of more experienced members of their community (Sackett 1990; Wegner 1998). As such, similar manufacturing choices and practices are often centered within a community and are visible with the finished products created by related manufacturers. Archaeologists often describe these related manufacturers as forming a shared "community of practice" (Lave and Wenger 1991) and have traced their distribution over time and space as indicative of past societal groups (Ferri 2011; Snyder 2016; Starzmann 2011; Wiessner 1983).

In this thesis, I explore the applicability of using geometric morphometric software to define past communities of practice by measuring variability in stone tool morphology from a single archaeological site. My focus is the Late Archaic (3,000-1,500 B.C.) Northeastern United States; a time and place where larger societal bodies are thought to form (Sassaman 2010:9). Archaeologists debate why larger and better defined societal groups formed during the Archaic, with many focusing on changing climatic conditions, rising population levels, and technological advances as the causes (Claassen

1996; Clay 1998; Dye 1996; Marquardt and Watson 1983; Ritchie 1969; Sassaman 2001, 2010; Sassaman and Holly 2011). While most archaeologists recognize the Late Archaic as a period of rising social and regional diversity, tracing the presence of distinct societal groups remains mired in the use of idiosyncratic measurement techniques and traditional typological schema used to capture variation in hafted biface form (Miroff et al. 2009; Ritchie 1971; Versaggi et al. 2001).

I address the shortcomings of current measurement techniques and typological schema by focusing my research on the Lamoka Lake site located in Schuyler County, New York (Figure 1). Lamoka Lake dates to the Late Archaic and is notable for its diversity of stone tools and spatial distributions of cultural remains (Curtin 1999; Ritchie 1932a, 1969, 1971). While biface diversity has been explored on other Late Archaic sites, Lamoka Lake has a wide variety and notable quantity of bifaces making it atypical for the period (Ritchie 1932a:89–98) This diversity has not been explored in much detail as William A. Ritchie, the original excavator of the site, categorized all the lithic tools based on a functional typology and then grouped those labeled "arrow-points" as "Lamoka Points"(Figure 2) (Ritchie 1932a, 1971). Ritchie's analysis remains in use and has not been updated over the last eighty years.

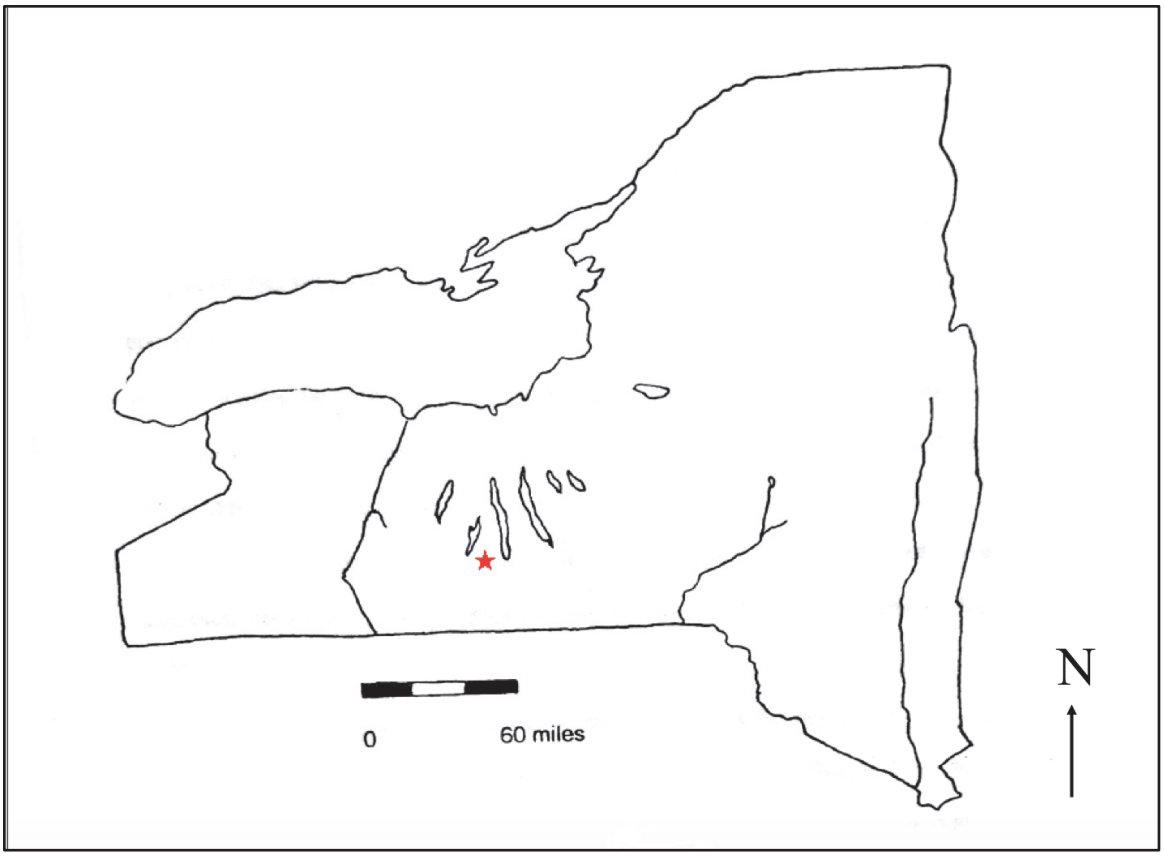


Figure 1: Lamoka Lake Site Location at Red Star (Adapted from Curtin 1999).

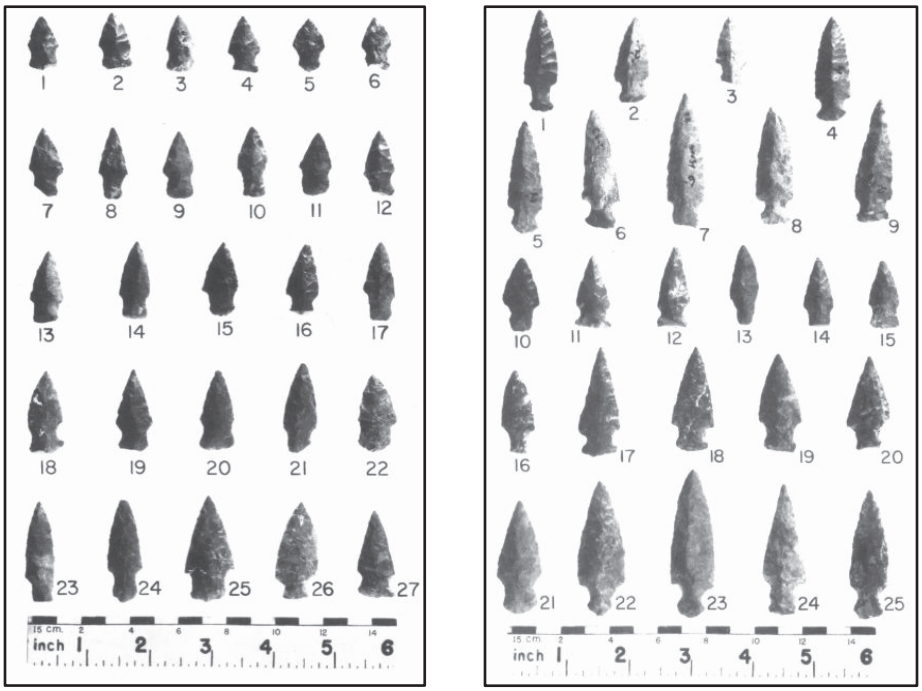


Figure 2: Samples of Lamoka Points (Adapted from Ritchie 1971)

Revisiting the Lamoka Lake collection is important as it was from this site that Ritchie developed the concept of the Archaic; a concept that has since been used to describe Native American communities across North America (Marquardt and Watson 1983; Miroff et al. 2009; Montet-White 1974; Sassaman 2010; Stoltman 1992; Versaggi et al. 2001). The Archaic, as Ritchie defined it, was a time in which people adapted to environmental conditions through the invention of new technologies and, the adoption of new settlement and subsistence strategies (Curtin 1999; Sassaman 2010).

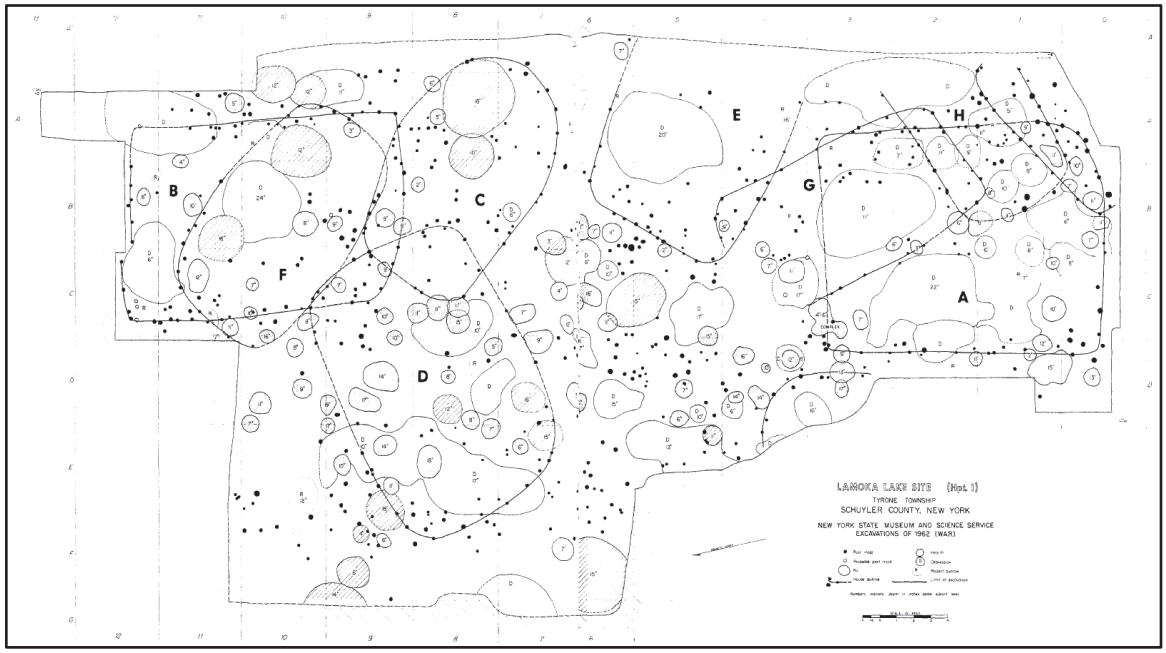


Figure 3: 1962 Excavation Site Map (Adapted from Funk and Ritchie 1973)

In creating such a broad category of human occupation in North America, Ritchie unwittingly created a large and homogenous "culture" that archaeologists eventually applied to people between the initial Paleo-Indian expansion into the New World and the Woodland invention of pottery and agriculture (Stoltman 1992:105; Versaggi et al. 2001:123). Over the last few decades, archaeologists have increasingly critiqued how the Archaic is often viewed as a monolithic period of time filled with hunter-gatherer

communities slowly adapting to their ecological conditions (Sassaman 2010). This thesis offers an additional critique to the monolithic Archaic as it investigates the diversity of peoples living at Lamoka Lake and the possibility that this period of time was notable for its socio-cultural variability.

Figure 4: An Exposure of Trench 1 (Adapted from Ritchie 1932a)

While Ritchie's research at Lamoka Lake helped define the Archaic it has been returned to infrequently and the diversity found within its lithic assemblage has not been addressed in decades. My research will expand our knowledge of Lamoka Lake by addressing the question of whether distinct groups (or communities) lived in the site. Using new advances in software, including geometric morphometrics, I will analyze the hafted biface collection from Lamoka Lake to determine the level of variability with the assemblage and whether this variability may relate to socio-cultural diversity. In returning to the Lamoka Lake collection, the site that helped define the Archaic concept, we are afforded an opportunity to answer modern questions with the original and foundational Archaic data.

Results

In the following chapters, I present research that suggests Lamoka Lake was occupied by multiple groups. This is based on the presence of two distinct groups of morphological similarity that are separated by haft shape. A Principle Component Analysis (PCA) clearly demonstrates this separation. While it is possible that these two distinct groups reflect different functional needs, the basic dimensions of the bifaces suggest this is not the case. Across the sampled collection, over 75% of all maximum lengths, maximum widths, and maximum thicknesses were confined to strict limits. Such similar dimensions suggest a similar purpose across much, if not all, of the bifaces. A mix of depths (suggesting time) and an almost uniform raw material across all samples suggest that this variability is not related to traditional explanations of variability or even Ritchie's initial delineation of two forms of the Lamoka "type."

Through this research I propose that there are at least two individual groups/communities represented within the Lamoka Lake hafted biface assemblage. Using concepts developed in the communities of practice literature and applying them to the analytical results of the geometric morphometrics I will argue that the commonalities and variation seen in the shape of the hafted bifaces are sufficient to determine distinct patterns of production. These production patterns can then be thought of as physical indicators of traditions shared by the groups that produced them. The nature of group differentiation is unclear: groups may have had different languages, ethnic identities, or histories. Without further studies, it is impossible to understand the nature of group differentiation, but my analyses clearly show that groups residing at Lamoka Lake formed their bifaces in consistently different fashions.

Roadmap

In Chapter 2 I will discuss the theories and previous research that informs my studies. I will start with a background on how the notion of the Archaic was formed, how it developed, and how it applies to Lamoka Lake (Miroff et al. 2009; Ritchie 1965; Sassaman 2010; Versaggi et al. 2001). I will then highlight how Lamoka Lake contained large quantities of artifacts and may have therefore been populated by relatively large numbers of people. The population levels found at Lamoka Lake are uncommon and suggest that communities would have become increasingly complex and diverse. Communities of practice will also be discussed as they apply to the ideas of social complexity/diversification at Lamoka Lake (Carr 1996; Sackett 1990; Wiessner 1983). These will be discussed in order to provide the framework for conceptualizing what the division in biface morphological similarity can suggest about the Lamoka Lake people.

Chapter 3 will examine the analytical methods used focusing on the process of gathering the shape data. Identification and measurements were taken using digital photography and computer analyses, including TPSdig, PAST (Paleontological Statistics) (Hammer et al. 2001), and R Statistics (R Core Team 2017) with the MOMOCs package (Bonhomme et al. 2013). To test the validity of my claims I will use a series of statistical tests such as student t-Tests, MANOVAs, and ANOVAs to see if my results were simply random occurrence or non-coincidental.

In Chapter 4 I will present the results of my research in the form of PCA charts, frequency histograms, x-y plots, and tables offering attribute counts and the results of the statistical analyses. I then will analyze results and incorporate them with the theoretical

background of this project to support my claim that this collection shows signs of group diversification at Lamoka Lake during the Late Archaic.

My last chapter will review what has been found during this research and restate the claims I have made. By the end of this project I will have addressed the underlying question I began with: Was social diversity present or developing within the Lamoka Lake population? I then conclude by suggesting avenues of future research on this subject as well as this site and region. Our understanding of this time period and this region has not fundamentally changed in decades and I hope this work inspires future researchers to deepen our understandings of the Northeast Archaic.

Chapter 2: Literature Review

Lamoka Lake, an important archaeological site that has fascinated archaeologists for many generations, lies between two small glacially carved lakes in central New York. The region surrounding Lamoka Lake is marked by waterways, swamps, and lakes that contain an ecological abundance thought to be the main reason Archaic peoples selected these locations to inhabit thousands of years ago (Ritchie 1932a:80). While Archaic people living in the region are often thought to be seasonally nomadic hunter-gatherers, the density and diversity of artifacts and features recovered at Lamoka Lake suggest a much longer and more stable occupation at the site. The richness of finds and extent of Lamoka Lake are unusual for the Late Archaic and provide a unique research opportunity.

In part because it is so rich and expansive, Lamoka Lake is widely known among archaeologists. Lamoka Lake has also lent its name to a projectile point, and has achieved even greater notoriety as it was here that the Archaic period was defined (Ritchie 1941:178; Stoltman 1992:105). While Lamoka Lake is relatively well-known, the region around it has only recently begun to be explored in more detail (Curtin 1999; Madrigal 1999; Miroff et al. 2009; Versaggi et al. 2001). Below, I offer a review of prior work conducted at Lamoka Lake and its broader impact on how archaeologists have defined and applied the Archaic, both in the Northeast and more broadly. I then turn to the concepts developed in the communities of practice literature to explore how we

understand variation in the material record and ways that we record and analyze this variation.

Lamoka Lake Site Research

The Lamoka Lake site and its material culture are unique and have been sporadically studied over the past decades (Curtin 1999; Funk and Ritchie 1973; Handsman 1979; Madrigal 1999; Ritchie 1932a). The site was initially identified in 1905 by Arthur C. Parker and his field assistant Everett R. Burmaster when a farmer turned up Native American artifacts while plowing his field. The site was not excavated until 1924 when a "collector," A. Frank Barrott from Elmira (Ritchie 1951:130), conducted excavations during the summers of 1924-25. During these investigations, Barrott opened shallow test pits in which he found projectile points, celts, adzes, mortars, and most notably a shell heap near the surface that contained early traces of pottery (Ritchie 1932a:81). William A. Ritchie, along with his brother Donald Ritchie and Harrison Follett conducted more systematic excavations under the frequent supervision of Arthur C. Parker during the falls of 1925 and 1926, and returned during the field seasons of 1927 and 1928 to better determine the age of the site (Ritchie 1932a:83). Work conducted during these field seasons revealed a notable depth of stratigraphy at the site, something rarely found at Archaic sites and is generally indicative of long term occupation.

Spatially, the Lamoka Lake site covers about an acre of land between Lamoka Lake to the south and Waneta Lake to the north. During his initial phase of excavations, Ritchie uncovered a vast collection of artifacts; including more than 700 "chipped stone implements." He initially organized these implements into five functional categories: arrowpoints, javelinheads, spearheads, knives, and perforators (Ritchie 1932a).

Fundamentally, these categories were based on the overall size of the implements, which he associated with function. Ritchie's initial analysis suggested that out of approximately 681 "arrowpoints" only 20 were not of the exact same style (Ritchie 1932a).

While Ritchie originally argued that Lamoka Lake was seasonally occupied, the current leading interpretation of the site is that occupation was year-round (Versaggi et al. 2001; Ritchie 1965; Miroff et al. 2009; Madrigal 1999). Year-round occupation is unusual during the Archaic in New York since this period is often thought to be dominated by nomadic hunter-gatherer groups that did not maintain residence at a single site (Ritchie 1941:178).

The community make up of Lamoka Lake has long been a subject of sporadic study, including Ritchie's initial attempts to define two distinct peoples based on cranio-morphology (Ritchie 1932a). Ritchie defined both dolichocephalic (longer skulls) and brachycephalic (shorter skulls) populations at Lamoka Lake, evidence, he suggests, of diverse peoples coming into contact with one another (Ritchie 1932a:117, 1932b:409; Curtin 1999:6). The idea of multiple groups encountering one another during the Late Archaic was further substantiated by research at the Frontenac Site in Cayuga Lake, which found a similar patterning of brachycephalic and dolichocephalic burials (Funk and Ritchie 1973:45–46). According to Ritchie, the meeting of these two peoples was violent, as evidenced by a series of burials at Lamoka Lake where the dolichocephalic skeletons showed signs of mutilation and the brachycephalic skeletons were placed in intrusive burials (Ritchie 1932a). Likewise, brachycephalic skeletons at Frontenac Lake also showed signs of violent death (Funk and Ritchie 1973:45–46). To Ritchie, this suggested a clash between two groups, which he eventually linked to the presence of two

different stone tool types in the region (The Narrow-Stemmed Tradition and the Laurentian Tradition). The bio-cultural approach to group identification fits into the dominant culture-historic idea of the era in which bounded cultures often collided with each other. The possible presence of distinct social groups has not been directly addressed at Lamoka Lake since Ritchie's identification.

William A. Ritchie's Archaic

Prior to Ritchie's work, our understanding of human occupation in the Northeast was based on the work of his mentor, Arthur C. Parker. Parker (1922) defined four prehistoric periods in the Northeast: the Algonkian, Eskimo-Like, Mound Builder, and Iroquois. The oldest of the four, Algonkian, was one that Parker stated "stretch[ed] back into comparatively remote times" (Parker 1922:48). Parker's categories are problematic as they were heavily based on comparisons to historic data, such as written observations of explorers and settlers in the region since archaeology in the region was in its nascent form he did not have the wealth of physical evidence that we have today.

Ritchie's excavations helped alleviate this lack of physical evidence and provided an opportunity to define cultures distinct from Parker's previous designations (Curtin 1999:6). Based on his findings, Ritchie subdivided the Algonkian period into the Archaic, second period, and the third period. According to Ritchie, the Archaic was one of the earliest periods of human history in New York (Ritchie 1938:103; Stoltman 1992:105). Ritchie's definition of the Archaic was based mostly on what it lacked including: agriculture, pipes, copper ornaments, shell artifacts, polished stone artifacts (except bannerstones), mortuary offerings, and pottery, as well as a few objects that it did retain such as, chipped stone tools, bone tools, and bannerstones (Curtin 1999:3).

To Ritchie, the Archaic emerged as groups adapted to increasingly localized environmental conditions (Ritchie 1965). Ritchie's definition of the Archaic was powerful as it could be applied beyond the geographical limits of the Northeast as it described a broader pattern of living that could be inferred across similar artifact assemblages. This is likely the most significant aspect of Ritchie's development of the Archaic as it provided a model for interpreting the archaeological record through the lens of environmental adaptation (Curtin 1999:11). Within the Northeast, Ritchie thought of the Archaic as a "forest-adapted" culture that formed based on its adaption to forest ecosystems (Ritchie 1965; Funk and Ritchie 1973:41). Water was also an important aspect of the Northeast Archaic: Ritchie showed almost all of the known Archaic sites in New York were located in close proximity to either a large body of water or a waterway (Funk and Ritchie 1973:41; Ritchie 1965). These findings led Ritchie to develop an understanding of Archaic peoples as closely attuned to their ecological surroundings and largely defined as adapting to those local conditions. In describing the Archaic in this manner, as a stage of adaptation, Ritchie helped to facilitate archaeological comparisons across time and space in North America as archaeologists from across the continent began describing past Native American populations in similar fashions (Stoltman 1992:105).

The Archaic More Broadly

While Ritchie (1965) initially defined the Archaic as part of a larger cultural-historic pattern, his later synthesis of New York State archaeology shifted the Archaic into a stage of cultural development. Briefly, the difference in these two terms is that a pattern is, according to the McKern taxonomic system (1939:310), a collection of phases

that broadly share the same traits. In contrast, a developmental stage draws from ideas of cultural evolution in which the Archaic is a stop in the growth towards "civilization" (Trigger 2008:348). As a developmental stage, the Archaic became a useful category for describing cultural advancement that could be applied to a wide range of archaeological data because it was not regionally or temporally specific, but rather only required relative time measurements and could be applied across a vast variety of material evidence (Sassaman 2010:13). In order to compare data on cultures across time a developmental stage requires stages before and after it; for the Archaic these were the Paleo-Indian and Woodland respectively (Figure 5) (Curtin 1999:7).

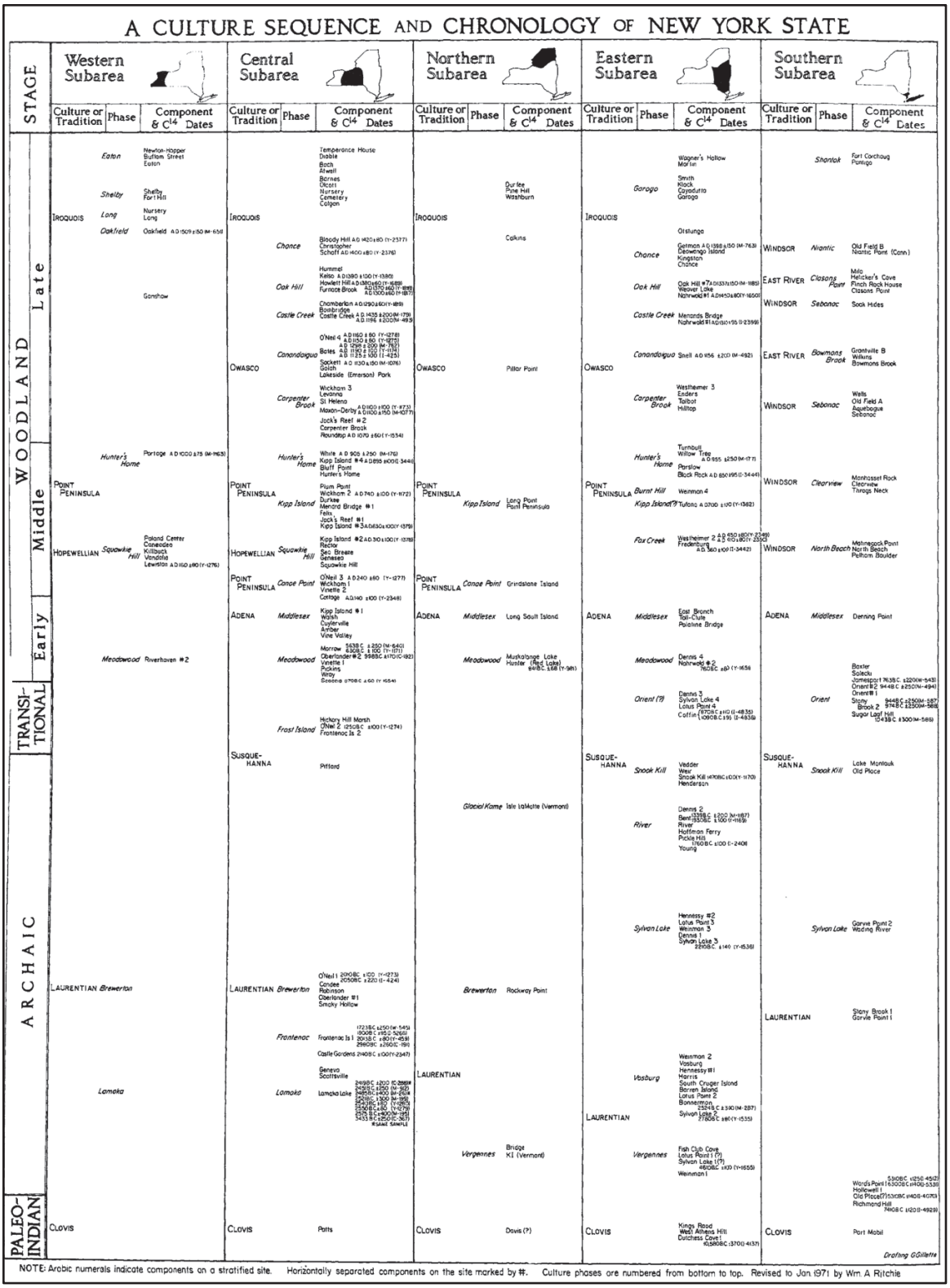


Figure 5: New York State Cultural Sequence (Adapted from Funk and Ritchie 1973)

During the 1950's, archaeologists either focused on developing local archaeological sequences or attempted to promote the Archaic as a pancontinental evolutionary stage through their work. The problem that arose out of these processes, though, was that making the Archaic pancontinental had the tendency to obscure the actual regional variation that was being uncovered as more excavations and work were being done (Sassaman 2010:8). In obscuring these regional variations, archaeologists did not focus on how any variation developed but instead looked to refine chronological placement. More recent research threatens the homogenizing view of the Archaic however, as this period is now increasingly viewed as a time of explosive diversification in the material record and intense localization of peoples (Versaggi et al. 2001; Sassaman 2010).

The Archaic has since been split into three arbitrary subdivisions, the Early Archaic, the Middle Archaic, and the Late Archaic (Figure 6) (Sassaman 2010:21). These subdivisions have been given calibrated dates and distinct reasons for their delineations, however, problems with their validity have surfaced. As an example, Sassaman (2010:22) points out that the separation of the Paleo-Indian from the Early Archaic is generally thought to be indicated by the move from lanceolate bifaces to forms that have notching in their haft element. What complicates this notion is that Early Archaic projectile point forms were offshoots or simply a new way to make Paleo-Indian lanceolate bifaces, which suggests continuity rather than separation (Sassaman 2010:22).

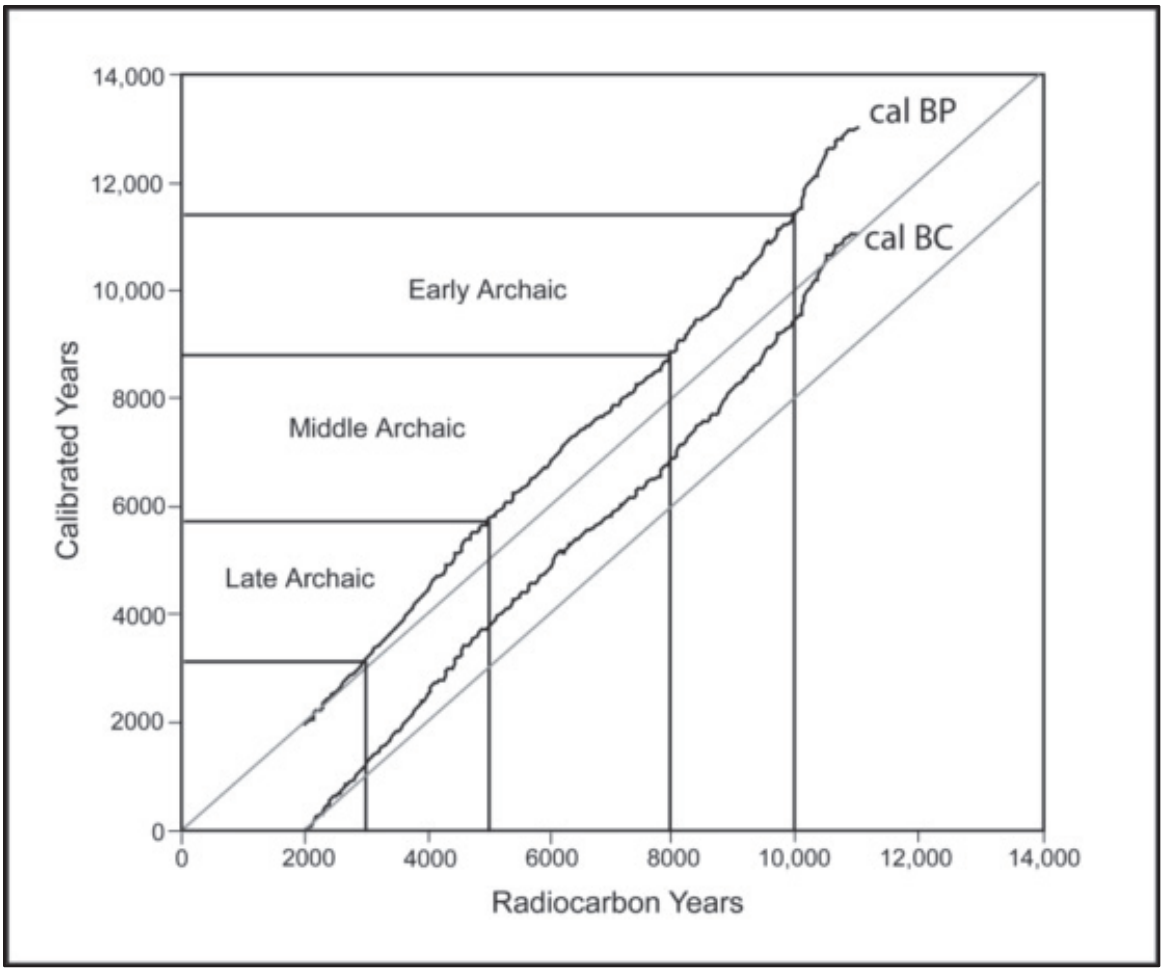


Figure 6: Calibrated Archaic Radiocarbon Years

These three subdivisions stretch over an immense amount of time in comparison to other periods. Sassaman (2010:5) notes that the Archaic stretched through 8,300 years of the roughly 13,500 years of pre-Columbian human existence in North America. While various sites across North America can be considered Early Archaic and Middle Archaic it appears that in New York the only significant manifestation of the Archaic is the Late Archaic, which is dated to circa 3500 – 1300 BC (Ritchie 1965, 1985:415). In fact, research into Archaic cultures has shown the wide variety of groups lived throughout North America. A common theme across all this variation is that they are all nomadic hunter-gatherers, from California to South Carolina (Foster et al. 2012; Palmiotto 2011).

While these nomadic hunter-gatherers did not generally stay in one place for long they still did leave behind materials, such as uniquely designed bifaces, that can be correlated to each group to help distinguish them from each other.

Research conducted at Lamoka Lake since Ritchie's initial work built on what he first offered as they have expanded our understanding of the site as an example of human adaptation to the environment. Curtin (1999) provided a better model of the hunter-gatherer lifestyle in the region concluding that the hunter-gatherers of this time were far more complex than previous interpretations suggested. He also helped to introduce the idea that projectile points and other finely made stone tools may have helped to define cultural boundaries in the Northeast (Curtin 1999:320–321).

Madrigal (1999) analyzed the faunal remains from Lamoka Lake to better define the diet breadth, evidence of sedentary behavior, and possible seasonal variation in foods consumed. In a similar fashion to Curtin, Madrigal (Madrigal 1999:339) concluded that the evidence he was examining indicated a much more complex society than previously thought where they were undertaking complex subsistence strategies that provided them with a great variety of foods. What both of these researchers offered was a contradiction to the generally held notion of simplistic nomadic peoples. This helps deepen our understanding of what happened during the Late Archaic and how the people were using this space, the region, and opened the door for questions of inter-site social complexity, like that offered in this thesis.

Social Groups and Their Communities of Practice

Research into the material correlates of social groups has been the defining goal of archaeology since the first archaeologist described a specific pot design as belonging

to a specific cultural group. This is evident in research done on all forms of archaeological material, projectile points being no exception. To define a prehistoric social group or community, archaeologists are only able to use the evidence they can gather in the field to explain the presence or absence of these.

Lamoka Lake is thought to have been a center of increased Late Archaic economic development, highlighted by the wide variety and quantity of foods found at the site, from acorn shells to white-tailed deer (Madrigal 1999). Whether you consider Lamoka Lake a seasonally occupied site or a site of year-round occupation the fact remains that its material evidence suggests the site's inhabitants were part of a large group or large number of smaller groups.

Communities of Practice

The question of whether there were distinct social groups at Lamoka Lake was initially tackled by Ritchie through his analysis of skull morphology (Ritchie 1932a). Though the bio-cultural approach is not taken in this thesis the same underlying question remains except shifted to material remains. The unusual level of preservation at the Lamoka Lake site offers a unique opportunity to possibly describe the process of social diversification in the Northeast. Analysis of the wealth of diverse artifacts and artifact classes recovered from the site opens many new lines of questions.

What if there were distinct social groups meeting and cohabitating at Lamoka Lake for some period of aggregation? How would that present itself in the archaeological record? Were these groups already established or were they just beginning to emerge?

These are important questions to ask because until now, the Late Archaic Lamoka Phase has been seen mostly as a period of cultural homogeneity based on the similarity of

projectile point style. In order to address these questions a rigorous examination of variation in the material culture record, specifically in the way that the projectile points from the site were constructed, will be undertaken. In selecting projectile points/bifaces as an indicator of social groups I am suggesting that they carry social messages through their style and design. According to Sackett's (1990:33–34) idea of isochretism style/variation enters the process of biface production when producers are aware of only a few production choices and subsequently tend to choose one. The choice they make is often one that they learned as they were enculturated into their social group (Sackett 1990). Sackett (1990:36) contrasts isochretism with the iconological approach, as he calls it, in which style is a product of conscious signaling of identity or membership instead of an unconscious product of what you have learned from your environment and peers.

Sackett's work emerged at a time when archaeologists struggled to define style and function and how these factors might be found within an object and how they might relate to social boundaries (Lemonnier 1986; Longacre 1981). One avenue of research that emerged from this discussion was the Communities of Practice (CoP) approach (Ferri 2011; Gilligan 2008; Lave and Wenger 1991; Minar 1999; Snyder 2016; Starzmann 2011; Wenger 2010). CoP focuses on materials as indicators of social groups. The underlying idea being that if groups are distinct enough they will have distinct ways of producing materials and it is these distinctions that will be reflected in the form these materials take. Being able to trace this variation can allow archaeologists to highlight possible social groups in the past and better examine social complexity.

CoP developed out of the practice theory developed by Pierre Bourdieu (1977) and structuration theory developed by Anthony Giddens (Giddens 1984). The evidence of these two theories are found throughout the literature. The use of these theories can be partially boiled down to the idea that while individual actors have choices they make them within constrained and somewhat pre-determined social environments. With both Bourdieu's practice theory and Giddens' structuration theory there is the allowance for change to be introduced but it requires actors become aware of their underlying social rules and then seek to change them. This general idea can be seen throughout the CoP literature as they discuss ways that the individuals make choices during construction that are socially constrained (Ferri 2011; Gilligan 2008; Snyder 2016; Starzmann 2011; Wiessner 1983).

For CoP theory the basic idea is that stylistic choices are not always conscious choices and people often decide to do or build things in the same way as their community because that is simply what they know. A useful way to visualize this is to think of the production process in three levels:

(1) The Technological;

(2) The Social;

(3) The Individual, Familial, and Psychological (Carr 1996) (Figure 7).

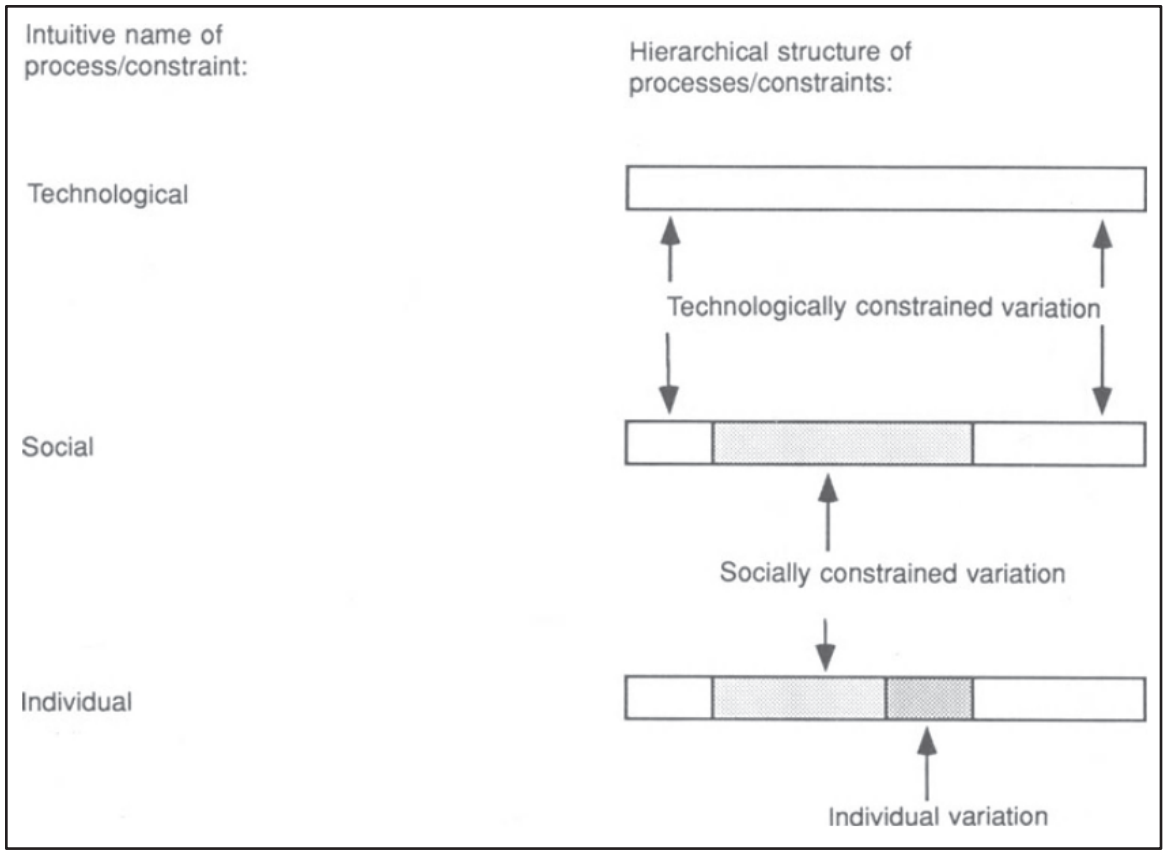


Figure 7: A Visualization of The Levels of Constraint (Adapted from Carr 1996)

These levels provide a framework for thinking about how projectile points are produced and what goes into the production process. These levels are the underlying structure of all of Carr's work on artifact design and can be used to hierarchically organize all aspects of projectile point design.

First, there are the basic and relatively unchangeable technological choices that must be made when constructing a stone tool. These include the quality of the material; access and availability of materials; the ways the materials can be worked; the tools available to work the materials; and what the purpose of the projectile point will be when completed. These constraints are essentially universal and inform all starting choices made by the people constructing projectile points. Second are the social constraints placed on the individual by the community. These are the choices being made regularly,

during construction or a point, by the larger group. As a member or participant within a group an individual learns from those around them and if the overall group makes a specific choice then the individual is likely to mimic this choice as a way to show conformity or allegiance. Third is the choices made by the individual. These are the micro-scale choices that are informed on a familial level as well as a personal and psychological level. Though these choices are personal choices of the individual they are constrained by each preceding level. As constraints are applied at each level deviations must also necessarily be created and it is at this level that conscious choices to deviate would made.

What is notable about these levels is that each subsequent level is constrained by the previous. Meaning, fine-grained personal choices are made within limits created by technological demands and social norms (Carr 1996). Though this hierarchy is developed it is not static because individual choices can eventually reach social levels thus changing the next sets of choices made during projectile point production.

What is important to understand in this discussion is that style does not necessarily preclude function (Carr 1996:182; Sackett 1977:370, 1990:34). This is especially the case with projectile point technology as every aspect of design can in some way affect the function of the projectile point. Style and function are inherently interconnected ideas and cannot be separated from each other. As outlined by Weissner functional properties can limit the stylistic features of an artifact to a few basic forms but the converse is also true where social choice can cause designs to remain simple (1983:258). Since style and function are interconnected and projectile points present a prime example of this interconnectedness, then the examination of stylistic variation in an

archaeological collection of projectile points can quite possibly detect the presence of distinct social groups.

If distinct social groups were present at Lamoka Lake then some level of group dynamics must have occurred as people taught and learned activities to and from one another. CoP is a theory that is focused on group dynamics. Its underlying tenets suggest that in order for a member of the community to be integrated they need to learn, generally from birth, how to participate with the whole. Fundamentally, and for the purposes of this project, this means that they learn how to produce material goods in the same ways as those around them (Ferri 2011). As mentioned previously this supports the idea that what is produced by someone who is integrated into a community is almost wholly informed by that community.

This theory does not miss the forest for the trees as there will always be the individual in the production of the materials. Wiessner posits a useful set of style categories when she discusses emblematic and assertive style. For Wiessner (1983:257–258) emblematic is style that has a clear and conscious affiliation to a larger identity which she suggests is represented in flags or emblems and assertive which holds a more personal quality for the producer and identifies more down towards the individual. These can be tied into Carr's (1996) discussion of the social level of material production and the production level involving the individual, the familial, and the psychological, respectively. When applied to the biface collection examined here, I propose that certain morphological distinctions could be an example of these styles, such as straight stemmed bifaces versus side-notched bifaces. What is important to note about these two styles is

that it highlights the idea that there are both conscious and unconscious choices that are made when a person is producing an artifact

Fundamentally, this is a melding of the debate around what motivates style. In this case the idea is that style can be one of two things. Either it is a purposefully produced product of an individual or style is inherent and the producer of the object almost essentially has no conscious choice in the matter. CoP does however allow for the possibility that both could be affecting the choices made by the individual. In viewing style as various parts purposeful action and as inherent, this theory can create a more nuanced understanding of the final product that researchers study.

At its heart CoP is a theory of learning and how that learning is shaped by a multitude of factors (Wenger 2010). It is applicable to biface production because the process of production requires an extensive period of learning and it is in that learning that some socialization into the community takes place. This socialization is also where the solidification of group identity begins to be formed since the individual is learning from the people they interact most with, naturally suggesting that they mimic and internalize similar practices done by these people. Most learning is done through observation (Minar 1999) and that act of viewing helps to further drive home the internalization of the practice. Internalization of practice starts a process of insulation which results in the individual beginning to identify themselves based on their learned practices. This allows them to distinguish themselves from others by claiming membership in the group they learned their practices from (Hu 2013).

An underlying goal of CoP research is to find evidence of past social groups and this is done through identification of difference in choices made at all levels of

production. Some CoP research has used ceramics as a source of this evidence (Gilligan 2008; Minar 1999). Since pottery is a learned practice that means it is influenced by what the producer is seeing in their community as well as what they are being explicitly taught. In focusing on the learned micro-techniques of production, such as cord impression and decoration choices, researchers highlight evidence of social identification.

The difference between production of ceramics and lithics is a case of opposites where ceramics is an additive process while lithics is a reductive process. Though these two technologies are opposites they still maintain a core feature which is that a human is altering something by making choices.

So just as ceramics is a learned skill so is flint-knapping. Every time a flake is removed from a core it becomes the product of a choice made by the producer (Snyder 2016:63) and after a series of these choices the shape is altered in a visually distinct way that identifies a distinct community of producers (Starzmann 2011:132). I suggest that using the newly developed geometric morphometrics can aid us in examining these changes and analyzing their ability to identify distinct communities exemplified by material culture and in this case bifaces specifically.

Pre-Computer Morphometrics

Before the advent of computer based photographic morphometric analyses, researchers developed methods to quantify and identify variability in lithic collections (McKern 1939; Ritchie 1971). Often this would start with simple visual differentiation where differences in shape would be identified, recorded, and plotted on charts organized by their stratigraphic placements at sites or in regions to provide a visual representation of the change in the object's variation over time. These charts, better known as seriation

charts, were often used as indicators of social groups/choices. When charted across whole regions seriations were thought to suggest either change in construction choices or change and movement through time of the peoples living in those regions.

Typology

Early attempts by archaeologists to identify variation in stone tools started with easily observable traits used to create "types." This included traits such as the general shape and size of the point. Initial descriptions of Lamoka points labeled them as straight or narrow stemmed points with a "rind" or more accurately the cortex still remaining on the base of the stem (Ritchie 1932a, 1971). This highly visible attribute, was and still is, considered one of the defining characteristics of the Lamoka point and has led researchers to consider the Lamoka stone tool technology as a pebble industry (Ritchie 1932a:94, 1971; Curtin 1999:142). A pebble industry is simply the use of local stones, often those found along waterways for the production of stone tools rather than traveling and gathering materials from a source. The small average size, the similar stem to blade thicknesses, as well as the frequent presence of cortex on the base of the stem, are characteristics usually identified as unique to Lamoka points and lend evidence describing these points as coming from a pebble industry. The nature of pebble industry determines the materials used by knappers, which in turn impacts the final product.

Based on his work and that of his colleagues, Ritchie (1971) created a projectile point typology that is still frequently used across New York State. The Lamoka points are a good example of Ritchie's typological techniques, which became commonplace by the 1960's. Ritchie's entry for Lamoka points starts with a drawing of the "average" point as a way to provide an ideal image in the reader's head while they read the more detailed

descriptions of the point. Following this image, Ritchie provides a general description of the point and describes it using basic terms such as narrow, straight, and what kind of notching the point may have. This is to provide a general enough description for the reader to direct them towards a point type that would match most closely with what they are observing in their own point collection.

After this general description, Ritchie provides the range of sizes for the point type along with any notable exceptions. These ranges represent what the majority of the points her surveyed measure to, although no indication of what a "majority" of points means is given. For the next step, Ritchie notes the proportion of the point. This measurement is found by comparing the maximum length to the maximum width of the point in order to provide a descriptor such as, in the case of the Lamoka point, "two to three times as long as wide" (Ritchie 1971). This attribute is based on having the point on a two-dimensional plane where the maximum length is from the tip to the center of the base and the maximum width is, generally, from barb or shoulder to the opposing barb or shoulder. After the proportions, Ritchie (1971) then provides a detailed shape description of the point. Here is where he uses terms such as trianguloid (when referring to its two-dimensional outline), biconvex (when referring to the cross-section), and excurvate (when referring to the shape of the edges or the base). Further in this guide is a brief description of the relative age and cultural affiliation. Once the point has been identified according to all previous traits, the reader is then able to place the point in an applicable chronological context. Here Ritchie (1971) provides the most accurate dates attributed to the points as well as the name of the cultural complex they are associated with. Once that has been given, the next section details, briefly, the general geographic distribution of the

point. After this there is a list of the reports and research that the entry is based on followed by remarks outlining some of the details that did not necessarily fit into the previous sections. Finally, at the back of the book Ritchie (1971) includes a sample of photographs for all of the projectile point types.

Ritchie's work on New York typology was not unusual - there were and are plenty of other examples of lithic stone tool typologies across the United States (Bullen 1968; Justice 1987, 2002a, 2002b). Ritchie's typology was developed through recommendations and suggestions provided by Alex Krieger (1944; Ritchie 1971) in his article "The Typological Concept." Ritchie used Krieger's article to develop the attributes used to describe the points he had been observing throughout the state. It is therefore not surprising that the types he developed came to define cultural development throughout New York since Krieger explicitly states that "…an archaeological type should represent a unit of cultural practice" (1944:272). By representing a unit of cultural practice it is not a far leap to then attribute it to a culture more wholly and descriptively (i.e., these are the Lamoka Lake people who make narrow-stemmed Lamoka points).

The use of the Lamoka Points as an example to outline Ritchie's method of typology is an interesting one because the Lamoka type has two notable forms: the straight stemmed and the side notched. Ritchie notes the similarity in structure between one form of the Lamoka point and the Dustin point described by Binford in Michigan (Ritchie 1971). After further conversations between the two men Ritchie, under the advice of Binford, suggests that there could be a chronological significance between the two forms and if there is, the two should be labeled Lamoka A (side-notched) and Lamoka B (straight). Interestingly, beyond this initial identification and description of

two forms of the Lamoka Points there appears to be no further research or discussion on whether they do represent a chronological difference. It seems to be that most Lamoka points that fit into either of these two forms are found in context with each other and share enough traits to simply be lumped together into the same point type.

In recent years, archaeologists have come to rely on new methods of analyzing stone tool shape as traditional methods of shape description are very subjective (Fox 2013:9). The choice of what should constitute a trait to record versus one to ignore is entirely up to the researcher and is not necessarily a representative aspect of the shape. While it may be systematic to select traits to measure and apply them across all tools studied, that does not mean that those selected are useful or meaningful traits for comparison between tools. The traits chosen could represent conscious design choices made by the producer just as easily as they could be choices restricted by the material of tool. Maintaining no control over how a design was chosen by an archaeologist makes this a difficult method to defend as replicable or rigorous.

The development of various attribute measurements that could be applied to bifaces was an attempt at standardizing the process of recording the shape of these points (McKern 1939; Ritchie 1932a, 1971; Thomas 1981). While effective at comparing single homologous variables across these points they do not necessarily describe the overall shape of the point. In essence, these original descriptive measurements reduced the projectile point to basic geometric forms, having a length, width, and thickness. Since these are generally measurements along straight lines they cannot account for curves in the shape of a point. Early attempts to gather data on the shape of curves focused on angle measurements but these still required that there was a point A that led to a point B

that then led to a point C. So instead of a single straight line two were used and the angle between A and C was used to describe the curve of a notch. These older methods of capturing shape data can still be used today but the process is assisted by the introduction of computer software focused on measuring and analyzing shape.

Computer Based Morphometrics

Morphometrics has always been a major method of lithics research in archaeology and has grown as an analytical approach with the introduction of geometric morphometrics developed in the biological sciences (Rohlf and Marcus 1993). The advantage that these computer powered geometric morphometric techniques have over the more traditional morphometric techniques is that they can maintain the geometry of the original object through all levels of analysis (Fox 2013:7). For instance, in maintaining the overall shape of the projectile point, the software can more objectively describe the shape and attributes of the point.

In mathematics, shape can be studied separate from size (Fox 2013:8) which allows for research focused on expressions of geometric shape to be done in a highly detailed manner. The two competing ways of capturing geometric shape are landmark and outline (Fox 2013:10). The difference between the two lies in what they are designed to capture.

Landmark analysis is similar to earlier analytical methods used by archaeologists. Landmarks were originally the aspects of the projectile point that a researcher subjectively decided were important to the construction, use, or design of the bifaces (Fox 2013:9). In biological sciences, landmarks are traits of an animal that are seen to be affected by morphological variation, for instance the location of a dorsal fin on a species

of trout. In marking where the fin attaches to the body researchers can compare variation across a sample of these fish, possibly highlighting relationships between species.

In the landmark approach for geometric morphometrics landmarks are placed at homologous locations (i.e., generalized locations that are shared between objects such as the tip, shoulders, the base, etc.) on the objects studied (Thulman 2012:1601). An advantage of this approach is the increased accuracy of object shape representation shape as it can show the shifts and changes in shape relative to other comparably outlined points (Rohlf and Marcus 1993:129). These geometric landmarks are different than traditional landmarks because they are better at showing "distances of maximum variation" as opposed to the traditional landmarks which more often than not are simply showing a unidirectional variable (Fox 2013:9; Rohlf and Marcus 1993:130). Geometric morphometrics inherently allows for multivariate analysis because it can represent multiple attributes simultaneously, which is crucial to any shape analysis. Since, it considers the entirety of the object's shape all at once rather than in pieces and at different times, comparisons are more complete and representative. Complete comparison is especially crucial when the question you are asking requires that you see the shape of a projectile point for everything that it is and how that can help infer social connections and differentiation.

The other method of data collection in geometric morphometrics is the outline approach. The outline approach is different than the landmark approach in the way that it collects data from the object. Outline data is representative of the two-dimensional boundaries of an object where all the data are collected on the outside of the object at equally spaced intervals (Fox 2013:10). This method is particularly useful when dealing

with objects that have curves in their shape and it is either impossible or difficult to determine meaningful landmarks. Projectile points exist in an interesting space between these two approaches as they can contain both curves and what could be considered meaningful landmarks.

According to Fox (2013:10) the two most common forms of outline analyses are the Eigenshape analysis and Fourier harmonics analysis. Eigenshape is more often used in conjunction with a landmark analysis because it measures the angles between points which allows for principal component analyses. Fourier harmonics analysis creates a series of mathematical functions that relate to a central point of the shape (Fox 2013:12). The basic form of Fourier harmonics, however, cannot work if the shape turns in on itself at any point since the outline would interfere with a direct relation to the central point. This was later accounted for with the development of Elliptical Fourier Analysis by Kuhl and Gardina (1982), a method that can account for complications in shape because instead of maintaining a central point from which to relate the functions, it instead produces an ellipse from which a harmonic is produced. All subsequent harmonics are then based off the initial one, which allows for the measurement of the shape to reach into curves where the outline would normally block a direct line from the center point.

The general progress of morphometrics in archaeological research has a followed a line from highly subjective attributes and traits measured because they were deemed the most important by appearance to a more standardized approach where all measurements were conducted in similar ways and on homologous aspects of the objects. Finally, the rise of morphometric analysis has corresponded to the use of computers, and the accuracy and consistency that they can provide. The use of computers to both describe and analyze

object shape has provided archaeologists with the opportunity to ask new questions and find more accurate ways to represent artifact shape.

An increase in the accuracy of the representation of shape, as well as the ability to analyze the shape itself, offers researchers the opportunity to see previously unnoticed or undiscovered levels of similarity. In doing this it may be possible to identify similarities that can tie the shape of an artifact, such as a projectile point, to a common mode of production which could then be tied to specific CoP and ultimately communities of Late Archaic peoples. With a collection such as the one from Lamoka Lake it may be possible to take the results of geometric morphometric analysis and develop a more enhanced picture of the past community makeup.

Chapter 3: Methods

For a long time, the underlying assumption of Late Archaic peoples was that they were part of a large and generally homogenous culture group. Recently, the emergence of social diversity and the potential for distinct cultural groups has become more of a focus with Late Archaic researchers in the Northeast (Curtin 1999; Madrigal 1999; Miroff et al. 2009; Versaggi et al. 2001). A perfect place to study the Late Archaic origins of social diversity and distinct cultural groups is the site of Lamoka Lake. Since it was first investigated in the 1920s and 1930s, researchers have noted a diversity of stone tools at Lamoka Lake, as well as other indicators that the site may have been occupied by multiple groups (Ritchie 1932a; Curtin 1999; Versaggi et al. 2001). Despite these early findings, the question still remains whether Lamoka Lake was home to a single homogenous population or was a location where diverse communities came into contact. My research is directed at determining if the site's diverse collection of bifaces could indicate the presence of distinct social groups.

From the quantified morphological data generated in this study it should be possible to determine if the Lamoka Lake site contains distinct clusters of points that could be interpreted as distinct communities. A lack of clustering (i.e., one overall cluster among all bifaces) could indicate that point morphology varied based on use history, planned function, or some other factor not necessarily related to the presence of distinct social groups. Importantly, results from morphological studies must be compared

to the traditional typology used to describe Late Archaic bifaces in the Northeast. If traditional morphological types and the morphological similarity clusters are largely the same, then it can be assumed that the traditional typologies are good indicators of the variation.

The Collection

The Rochester Museum and Science Center (RMSC) curates the Lamoka Lake artifact collection in Rochester, New York. When it was initially excavated in the late 1920's, Ritchie collected thousands of lithic tools and bone implements. For the purposes of this study, only the approximately 700 complete bifaces reported by Ritchie (1932a:91–96) along with an even larger and uncounted number of unfinished or broken bifaces are relevant. Ritchie never explicitly stated what his sampling strategy was so it is hard to determine how this collection was formed and if we are offered a representative sample from the site or only the highlights. He did briefly mention that there was evidence at Lamoka Lake for all levels of biface production (Ritchie 1932a:94) suggesting the presence of debitage in the archaeological record. After Ritchie collected and deposited the bifaces at the museum in Rochester each was assigned an accession number. This, however, was not a very thorough process as there were a few sets of bifaces that were assigned the same accession numbers and some that had none at all.

Ritchie did not categorize the bifaces beyond a simple visual analysis where they were grouped into categories based on an assumed use/function, such as arrow-points, knives, javelinheads/spearheads, and perforators (Ritchie 1932a). Since they were initially categorized during the late 1920's and early 1930's there has been no further analysis or recorded attempts to directly analyze the lithic materials from Lamoka Lake.

Ritchie did eventually define and categorize the variety of "projectile points" across the State of New York.

The Data

The data needed to study the question posed by this thesis will be drawn from photographs of 494 bifaces from Lamoka Lake by first outlining the point using the computer software tpsDIG. These outlines will be analyzed primarily using the MOMOCs package (Bonhomme et al. 2013), which has been specifically developed to handle the demands of morphological analyses in R statistics (R Core Team 2017). I will be looking specifically at the two-dimensional shape of each biface and comparing it against all others in the sample. My step-by-step methods are summarized below.

The Steps

Due to the size of the biface collection as well as the limited length of time in which I had for data collection I chose to photograph the bifaces in a standardized format with the intention of bringing the photographs back to Binghamton for later analysis. I collected photographs while conducting an internship with the RMSC as part of the MAPA (Master of Arts in Public Archaeology) program at Binghamton University. I decided photographs would be amenable to my research interests as I could use a combination of computer software, including tpsDig, PAST, and R with MOMOCs (Bonhomme et al. 2013; R Core Team 2017; Hammer et al. 2001), to record measurement from artifact.

Step 1: Typing

To gain a baseline understanding of the collection I determined that starting with Ritchie's (1971) typology I would categorize the bifaces based on his categorizations.

What I was looking for in doing this was to see if Ritchie's own typological categories held up to his descriptions. This data also had an added benefit of helping to generally date tools to the Late Archaic which will be an important factor later in my analysis.

The process of typing each point was simple it just required me to look for similarly designed points in Ritchie's typology. Once I was satisfied with visual matching I read the descriptions to see if those matched as well. This method of identification was not perfect as sometimes attributes of the points I examined more or less matched with multiple entries in the typology. To solve this, I would put those in question away and return to them later. I would then repeat this process until I was more satisfied with the accuracy of my identification. Once I had identified all those I had access to in the collection I totaled the counts to see what was in the collection as Ritchie would have viewed them.

Step 2: Photography

Photographs were taken using an iPhone 6 mounted to a photo stand. The iPhone was leveled using the phone's built in level application. The bifaces were placed on a board and positioned so that the bases were all aligned on the same spot for all photographs. Vertical neat lines that corresponded with the vertical neat lines in the camera application were added to the board to more accurately position the angle of the camera (Figure 8). Photographs were then cut down to only the inner neat lines to reduce file size when processing. Standardization of acquiring photographs was done to remove as much error as possible before the photos were processed through the computer software.

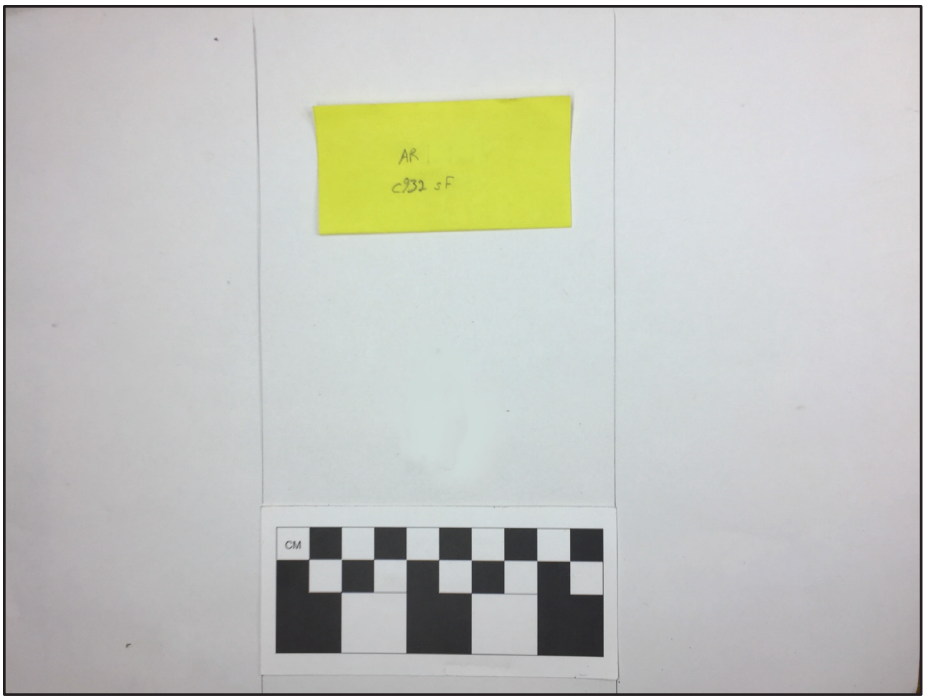


Figure 8: Photo-Board

The bifaces in each photograph were centered along their base and central axis. They were oriented to have the flat edge line up parallel with the base of the photograph. I made this choice because the general assumption about biface/projectile point/arrowpoint morphology is that the tip and blade are the functional ends of the tool and the stem and base comprise the less functional end. The difference between the blade and base is understood as such because whereas the blade and tip are designed to conduct a particular function, the stem and base are not as constrained. This is because hafting a biface only requires enough surface area to secure the tool to the shaft which gives the biface creator much more freedom in their design choices (Lipo et al. 2016:176). For the purposes of this thesis I suggest that this is where the most variation or conformity could occur and hence where the potential cultural/social information can best be expressed.

Step 3: Measuring

While I still had access to the bifaces I collected thickness measurements as they are impossible to gather through the angle of photographs I collected. I collected thickness measurements using digital calipers. I took a series of 5 measurements as the thickest point of each biface and averaged them together in order to calculate the most accurate maximum thickness I could. Each measurement was gathered and recorded onto an excel spreadsheet that would later house the attribute data as well as the outline data for each biface.

Measurements of maximum length and maximum width could be automated through the use of the computer software R which can be coded to both gather measurements from the outline and scale distances measured. Using a series of code adapted from Lipo et al. (2016) I was able to have R measure each outline for maximum length (from the furthest chart north pixel to the furthest chart south pixel) and maximum width (from the furthest chart west pixel to the furthest chart east pixel). This process is almost instant and since it is measuring based on static pixels then there was no need for multiple repetitions of measurements.

R measures based on number of pixels so in order to achieve real-world measurements I included a scaling factor of 65 pixels to a cm. The scaling factor was obtained by measuring a cm from the scale in around half of the pictures using tpsDIG. These were then averaged together and rounded down to 65 pixels. Once this was applied the results of measurements were stored as a variable in the R environment and were then able to be shown as a string of measurements. Once all three sets of measurements were in this form they could then be used to analyze patterns in generalized size.

Step 4: Outlining

The next step was to create a digital outline of each biface using tpsDig. This program has a built-in function that outlines shapes in photographs. For the most part this was easily accomplished for each picture, however, some photos needed to be converted to a pure black and white color scheme (Figures 9, 10, and 11). In Figure 9: Biface Outline Failure the outline appears in yellow and can be seen in the bottom left side of the tool ending before encompassing the entire biface. In order to solve this problem tpsDIG can convert the photo to black and white (Figure 10) based on the intensity of pixel's color the software can more easily recognize the edges of the object and outline it (Figures 10 and 11).

Figure 9: Biface Outline Failure

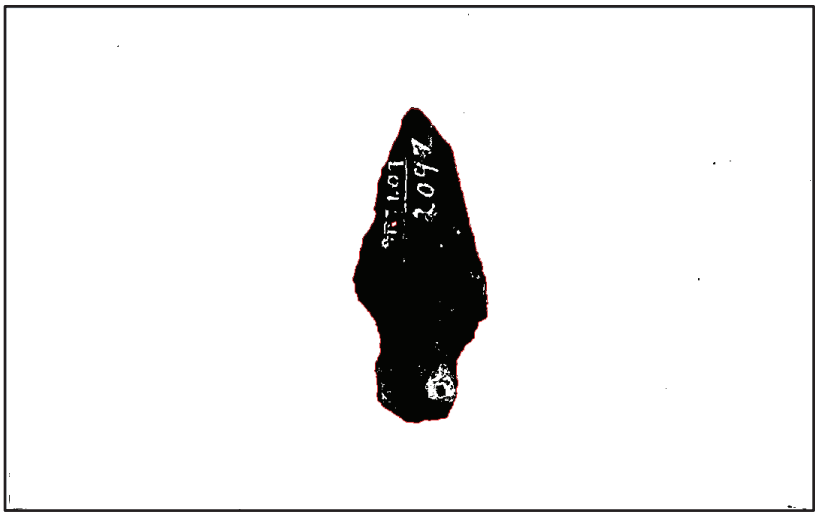


Figure 10: Converted Biface Picture for More Accurate Outlining

Figure 11: Biface Outline Success

The process of outlining utilizes the semi-landmark method. The software uses this method to take a set number of landmarks (chosen by the researcher before finalizing the outline) and applies them evenly along the edge of the shape. As can be imagined, the more landmarks the more accurate the shape but using too many landmarks becomes unwieldy for the program and will cause crashes. For this project, I chose to use 300 landmarks per biface applied evenly along the edge. I assumed this would be enough landmarks to provide a usably accurate representation of the shape of the biface.

Another outcome of producing outlines for all of the bifaces is that the outlines can be overlaid on each other. This allows for a visual representation of where commonalities in shape exist for the bifaces as well as showing the approximate average shape of the bifaces (Figure 12). While this is not a statistically supported product it is a direct and visually useful way of seeing the focus of shape variation. The stacked outlines help direct more targeted analyses of where significant differences in the biface morphologies are by showing both the most commonly similar aspects of the morphology as well as the least similar.

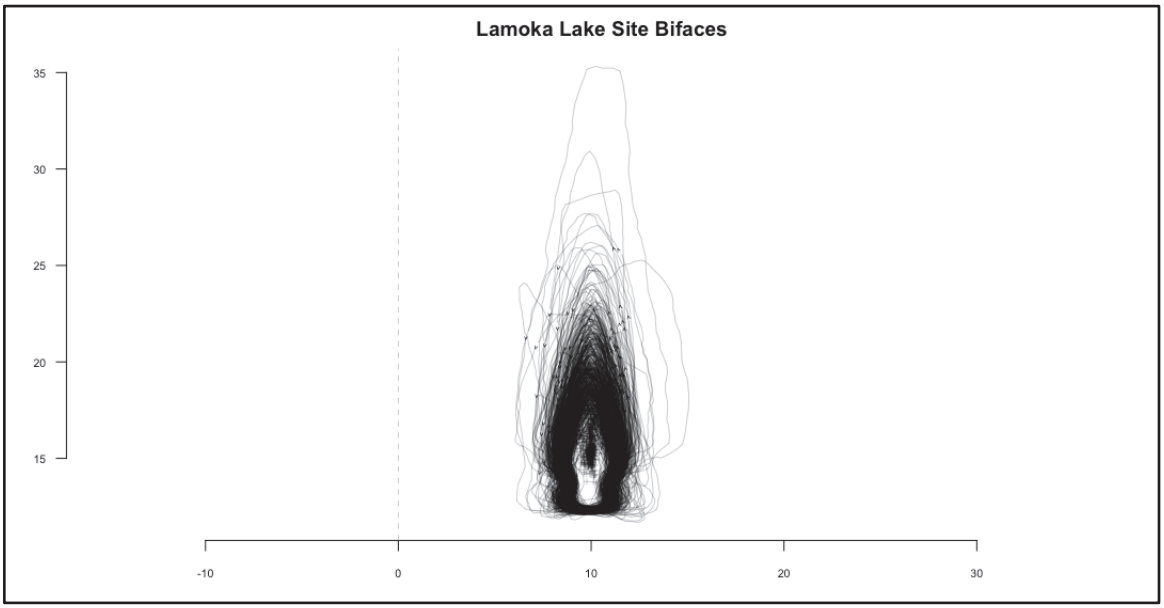


Figure 12: Lamoka Lake Biface Stack

Essentially, being able to target analyses on more variable features of the biface structure can reduce the amount of effort needed to locate variation that is presumed to hold more information about the construction and development of design. In the case of the bifaces from Lamoka Lake, the commonality in shape and size (i.e., the least variation) seems to be focused at the notching of the stem (Figure 12). A strong commonality also exists at the base but this is due simply to the previously discussed

positioning of the bifaces in the photographs. These results will be discussed and interpreted in more detail in the next chapter.

Chapter 4: Results of Analysis

The Lamoka Lake collection is a historically important collection that continues to help archaeologists better understand the Late Archaic people of the Lamoka Phase and the Finger Lakes region of New York. When Ritchie (1932a) initially looked at the results from his Lamoka Lake excavations he concluded that Lamoka Lake must have been a large village where two distinct groups, based on cranial morphology, that had fought over the space (Ritchie 1932a:132).

The Results

The results that I gathered from the Lamoka Lake collection have reasserted the original idea that there were two groups at the site, but in a different way. I will show, in the results of my morphological analysis, that there were two distinct designs in the collection that could indicate distinct groups of producers. The data offered below is a combination of traditional measurements (maximum length, width, and thickness) along with a statistical shape analysis using Principal Component Analysis (PCA). The results of the PCA show that there were two different ways of producing bifaces at Lamoka Lake.

Typological Assessment

My application of Ritchie's typology to the collection from Lamoka Lake resulted in a much wider range of stylistic variety in the collection than he had initially assumed (Table 1). This may be a result of Ritchie not returning to the Lamoka Lake collection for

typological analysis after he developed a more detailed set of types for his New York State Typology (Ritchie 1971). The wider variety of point types suggests that even in this older model of social group identification there were more groups of people living or aggregating at Lamoka Lake.

Table 1: Biface Type Counts

Traditional Morphological Type	n
Lamoka	398
Normanskill	38
Brewerton Side-Notched	12
Vestal	7
Levanna	5
Unidentified	5
Bare Island	4
Vosburg	3
Brewerton Corner-Notched	2
Jack's Reef Pentagonal	2
Otter Creek	2
Snook Kill	2
Sylvan Side-Notched	2
Beekman Triangle Point	1
Genesee Point	1
Greene Point	1
Madison	1
Perikomen Broad Point	1
Poplar Island	1
Rossville	1
Snyder's Point	1
Stubenville Lanceolate	1
Susquehanna Broad Point	1

PCA

The PCA (Figure 13) is the strongest indicator of morphological difference among the bifaces. The morphological difference is highlighted in Figure 14 where R uses a two-dimensional kernel density estimation and displays the results with contour lines (R Core Team 2017). The difference present in the sample is primarily in the form

of the base and stem and can be seen in the horizontal separation between the two groupings. Figure 13 shows this and suggests that while tip design fluctuates widely the base tends to cluster more closely on two different forms. It can be seen in Figure 15 that the two groups also do not align along any previously determined morphological type determinations. Indeed, most of the variation between the two groups occurs with bifaces typed as Lamoka points (Figure 15). When I remove all types that are not normally dated to the Late Archaic, which in this case are the Beekman Triangle Point, Greene Point, Levanna, Madison, Perikomen Broad Point, Rossville, Snyder's Point, Stuebenville Lanceolate, Susquehanna Broad Point, and those Unidentified (Figure 16). The separate clusters remain which further suggests that the clustering is largely found within Late Archaic point types rather than points from different time periods. The orientation of the clusters in Figure 16 has reversed from the other charts due to the absence of the non-Late Archaic points as their removal changed how the program quantified the results. Within a PCA, quantifications are relative so by removing some of the samples, the overall relations shifted, yet each data point's relationship to all others remains the same.

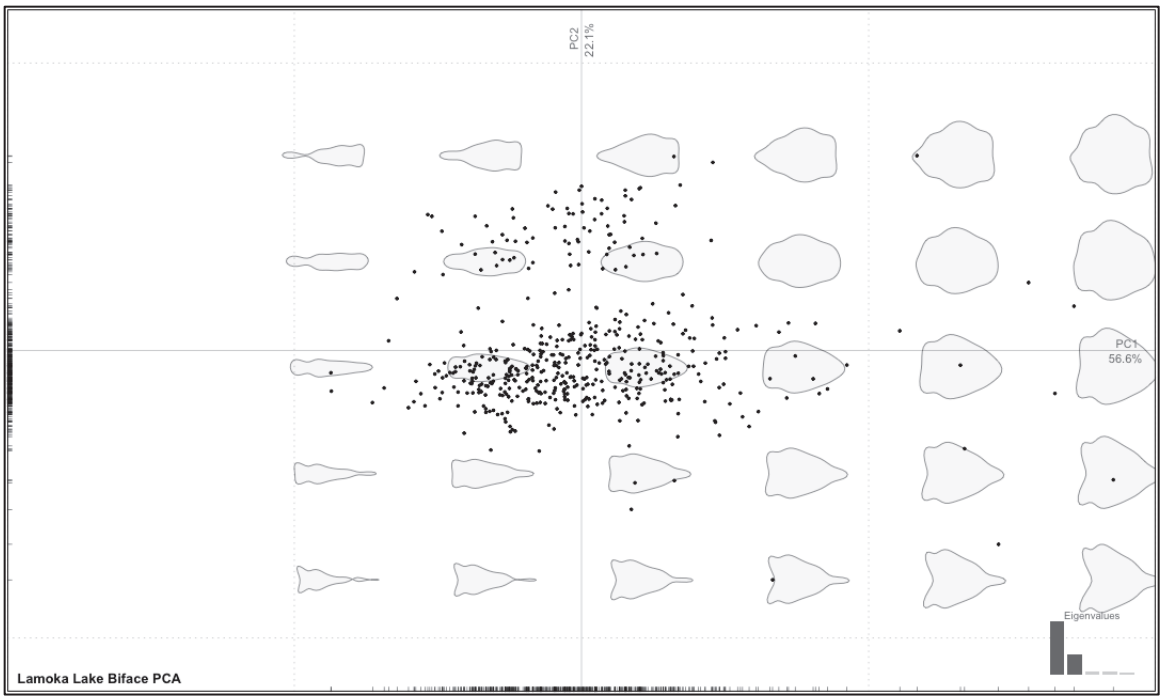


Figure 13: Lamoka Lake Biface PCA

The separation found within the Late Archaic points would presumably relate to the division offered by Ritchie who described both Lamoka A and Lamoka B types (Ritchie 1971). However, this is not the case. As can be seen in Figure 17, there is clear overlap between the straight stemmed and notched Lamoka Types and they are not isomorphic with the divisions found in the PCA analysis.

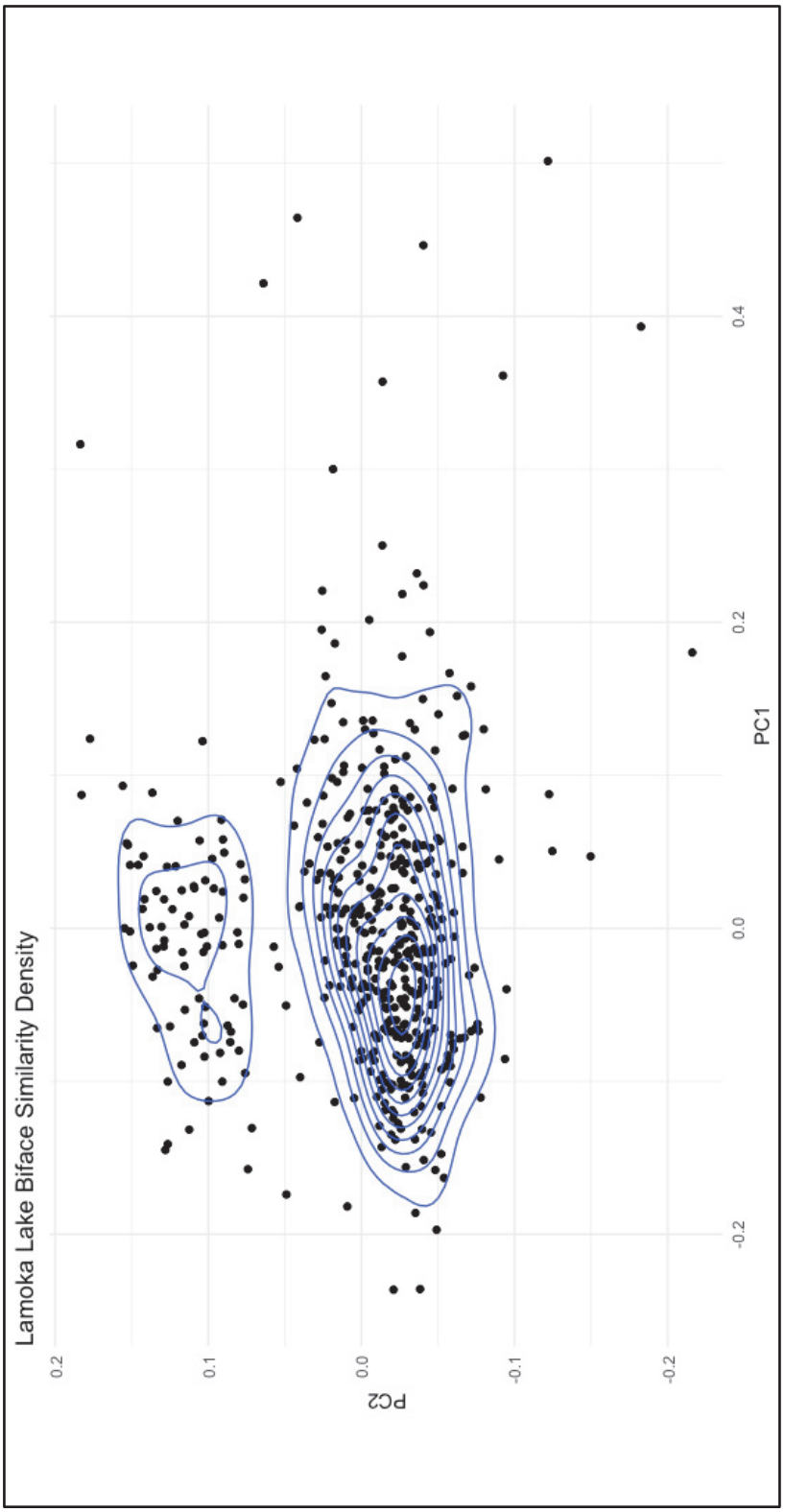


Figure 14: Lamoka Lake Biface Similarity Density

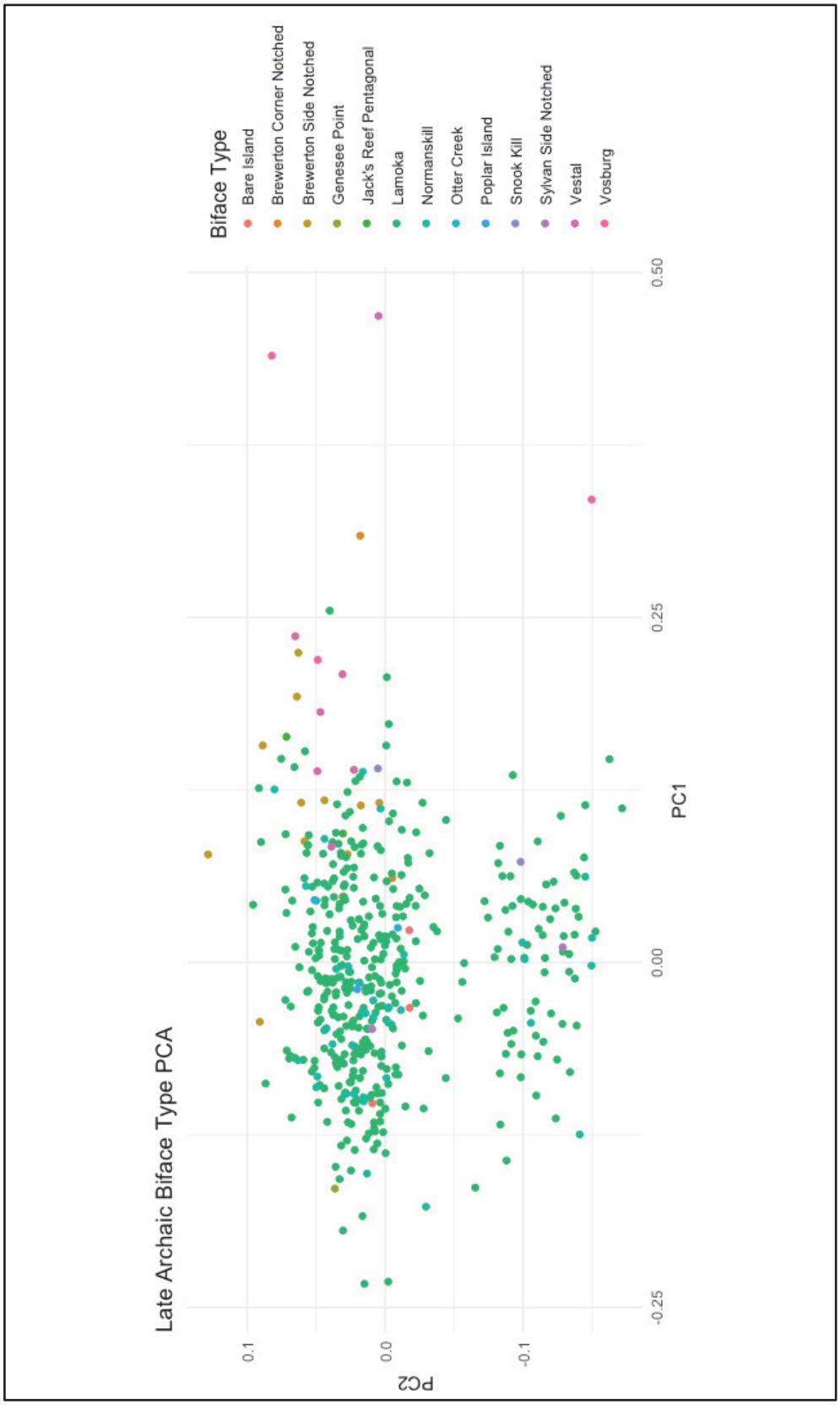


Figure 15: Traditional Morphological Type PCA

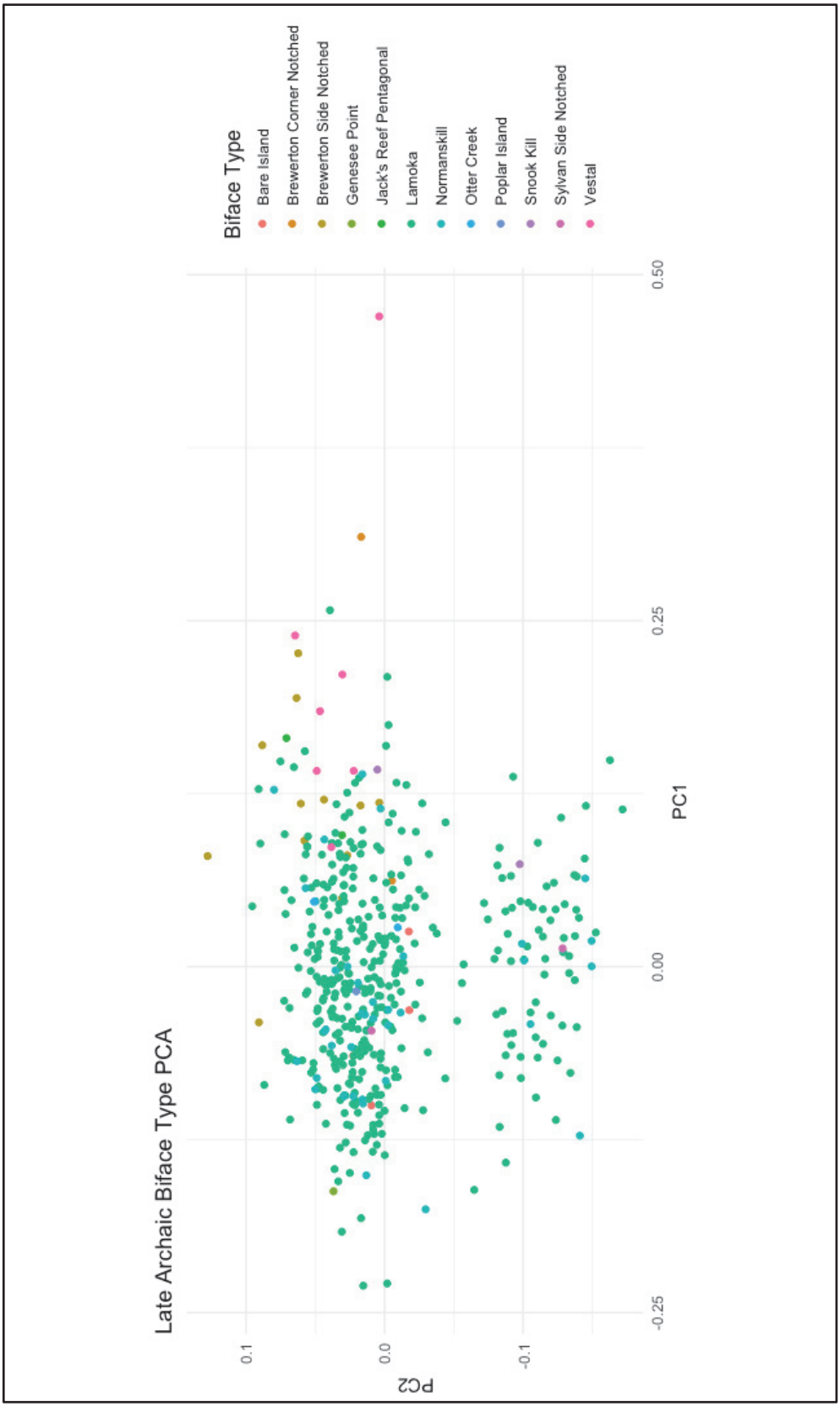


Figure 16: Biface Types Dated to The Late Archaic

Figure 17: Lamoka Sub-Type PCA

In Figures 14, 15, 16, and 17 there is a clear shape distinction in the traditionally typed Lamoka Lake biface collection. This distinction, which mainly exists within the Lamoka type, would suggest that there was a larger design that was being altered in two different ways. If the biface producers of Lamoka Lake were attempting to achieve an overall design then the size measurements of these tools should cluster around similar quantities.

Measurements

A possible explanation of the shape difference I found in this collection would be that they reflect two functional types. Perhaps one was used as a knife, the other as a spearpoint. If this is the case, then we can assume that the broader morphology of the tool would fall into different clusters. In other words, if I have combined two different functional categories together, we would assume that the overall shape of the tools would likewise fall into two different clusters. To determine the level to which the overall morphology of each point was similar, I measured the level to which the maximal lengths, widths, and thicknesses fell within specific limits:

- 87% of the maximum length measurements fall below 10cm with a mean of 7.733 cm and a standard deviation of 2.23cm.
- 86% of the maximum width measurements fall below 4cm with a mean of 3.339cm and a standard deviation of 0.84cm
- 96% of the thickness measurements fall below 1 cm with a mean of 0.7273cm and a standard deviation of 0.15cm.

The distributions of these dimensions can be seen in Figure 18 and the measurement comparisons in Figures 19, 20, and 21. The distribution of these measurements all fall

along semi-regular bell curves (Figure 18) and the student t-test results of each measurement set suggests that they are all non-random (Table 2). Functional differences between the various points did not fall into two groups. As such, the variability I detected likely was not caused by functional demands. Along that same point, it is worth noting again that the differences I detected were limited to shape of the basal end of the point. While this portion of the point is important for hafting and holding, it is not as directly linked to the overall function of the tool when compared to the size and shape of the blade and distal end.

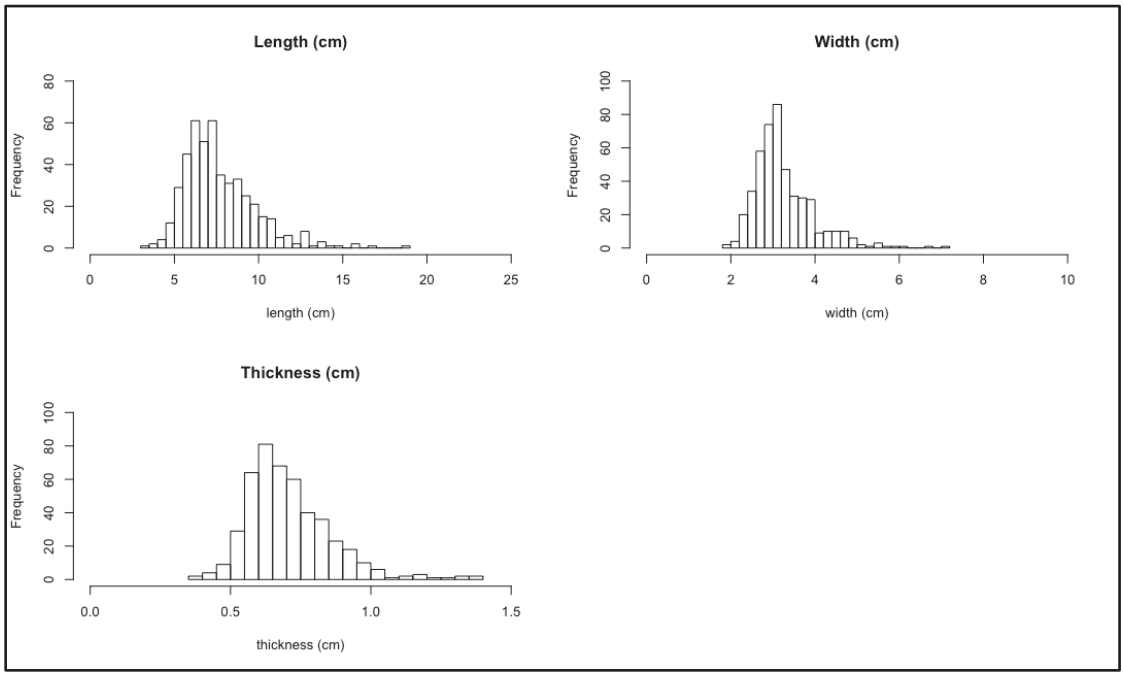


Figure 18: Measurement Frequency Histograms

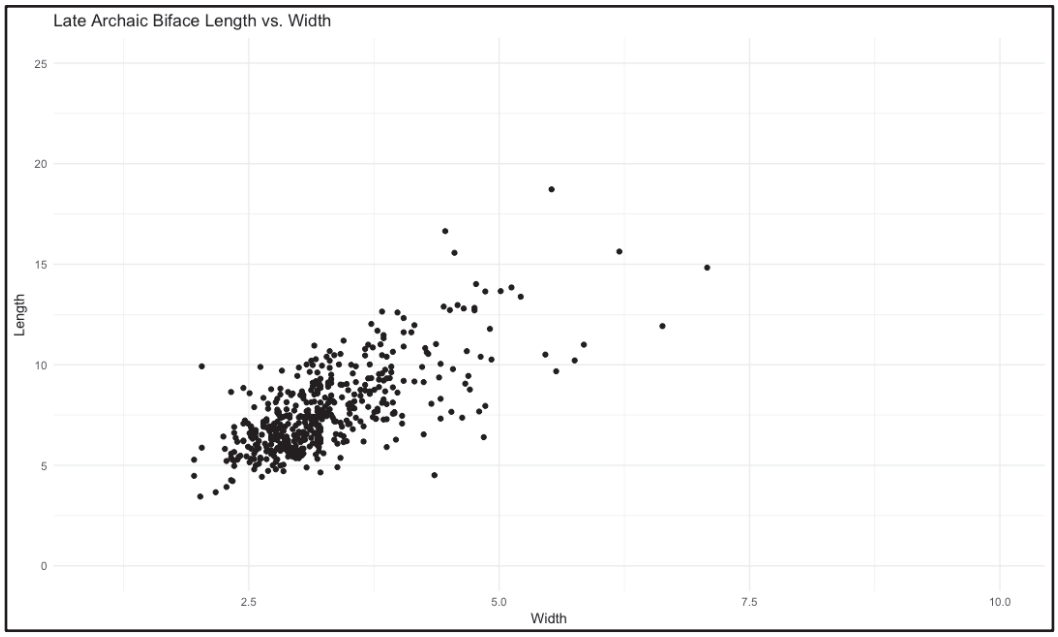


Figure 19: Biface Length vs. Width

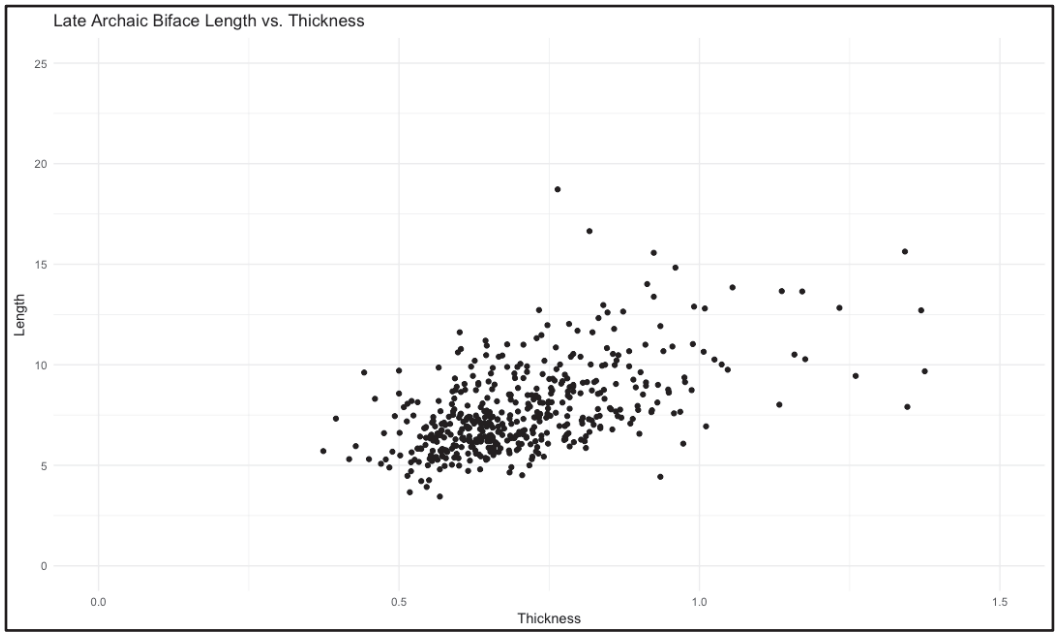


Figure 20: Biface Length vs. Thickness

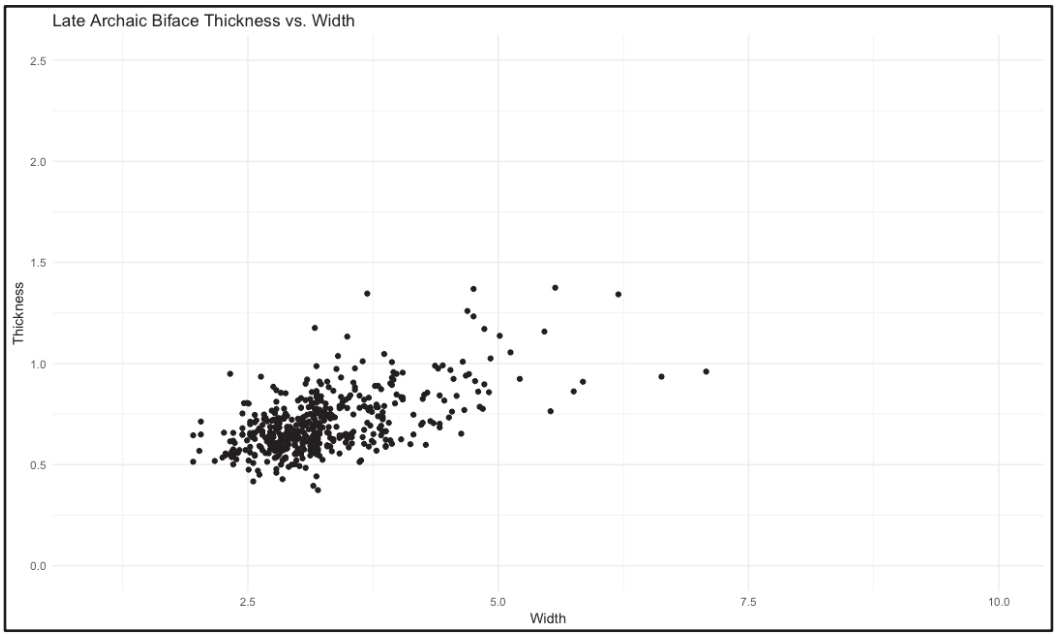


Figure 21: Biface Thickness vs. Width

The measurements (length, width, and thickness) were also compared with the other attributes (type and depth) from the sample to test against randomness using ANOVAs and MANOVAs (Tables 3 and 4). Material was not chosen as an attribute to test because all but five of the samples were the same material, so an analysis of that would likely be meaningless. Shape for these tests was assumed to be best represented by the combination of Principal Components 1 and 2 that were used to develop the PCA charts. To start the analysis, I first conducted MANOVAs of all attributes and measurements in order to see if combined they were non-random. This did prove to be the case. Then in order to parse out where significance specifically lay ANOVAs were conducted on sub-combinations of measurements and attributes. Not all of these attributes and measurements tested as non-random against shape when tested individually and partially combined using ANOVAs. Table 3 indicates which sub-combinations of attributes and measurements tested as non-random. When all attributes and measurements are compared

to shape they test as non-random which suggests that the biface shapes are an indicator of something significant in terms of our understanding of the Lamoka Lake people.

Table 2: Student t-Test Results

t-Tests Results	
Factor	*p-Value*
Length	< 2.2e-16
Width	< 2.2e-16
Thickness	< 2.2e-16

Table 3: ANOVA Results Summary

ANOVA Results	
Factors	*p-Value*
Lengths vs. Widths vs. Thickness	<2e-16
Shape (PC1 & PC2) vs. Biface Type	<2e-16
Shape vs. Lengths	0.01238
Shape vs. Depth & Length	0.01020
Shape vs. Type & Widths	0.00108
Shape vs. Lengths & Widths	0.01275
Shape vs. Type, Depth, Length, Width, & Thickness	0.02228

Table 4: MANOVA Results Summary

MANOVA Results	
Variables	*p-Value*
Shape (PC1 & PC2) vs. Type & Depth	0.004992
Shape vs. Length, Width, & Thickness	< 2.2e-16

This rough template of dimensions could also be constrained by the fact that all but five of the sample bifaces were made of Onondaga Pebble Chert. However, I think that this actually drives the point home further that there was a specific (successful) template that the Lamoka people were using. They were constrained by the material (pebble chert rather than quarried blanks) which also placed limits on the dimensions of each piece. Despite these constraints of material, there remains a divergence of

morphology in the overall sample that suggests there was another level of design that influenced their choices during production.

Depth of Bifaces

One possible explanation of this shape difference is that the bifaces were from different time periods of occupation at Lamoka Lake. This is not supported with the data from the site. Figure 22 shows that the data the distribution across the two morphological groups is relatively random at arbitrary 5cm intervals of depth. This randomness does suggest that this difference in design persisted across the entire occupation of the site.

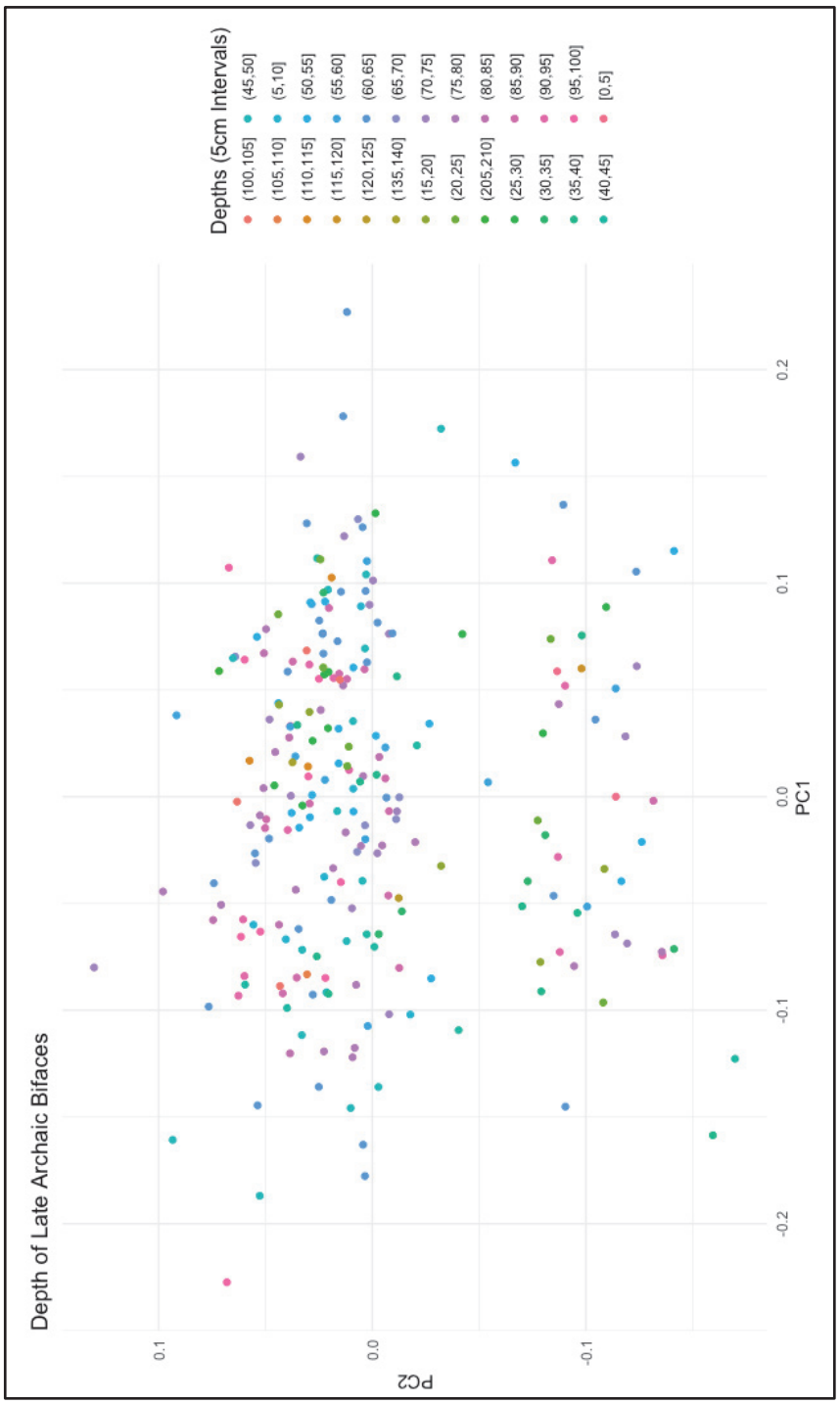


Figure 22: Lamoka Lake Biface Depth PCA

The depth information can also be shown as a generalized stratigraphy chart. With Figure 23 the horizontal axis is not representing spatial distribution across the site as this was not a variable easily examined with this collection. It is still useful to represent the

data in this way because it highlights the non-patterned nature of the depths these lithics were collected from. As can be seen in the chart depth of find did not align with the groups and examples found between both groups were found throughout the range of depths at the site.

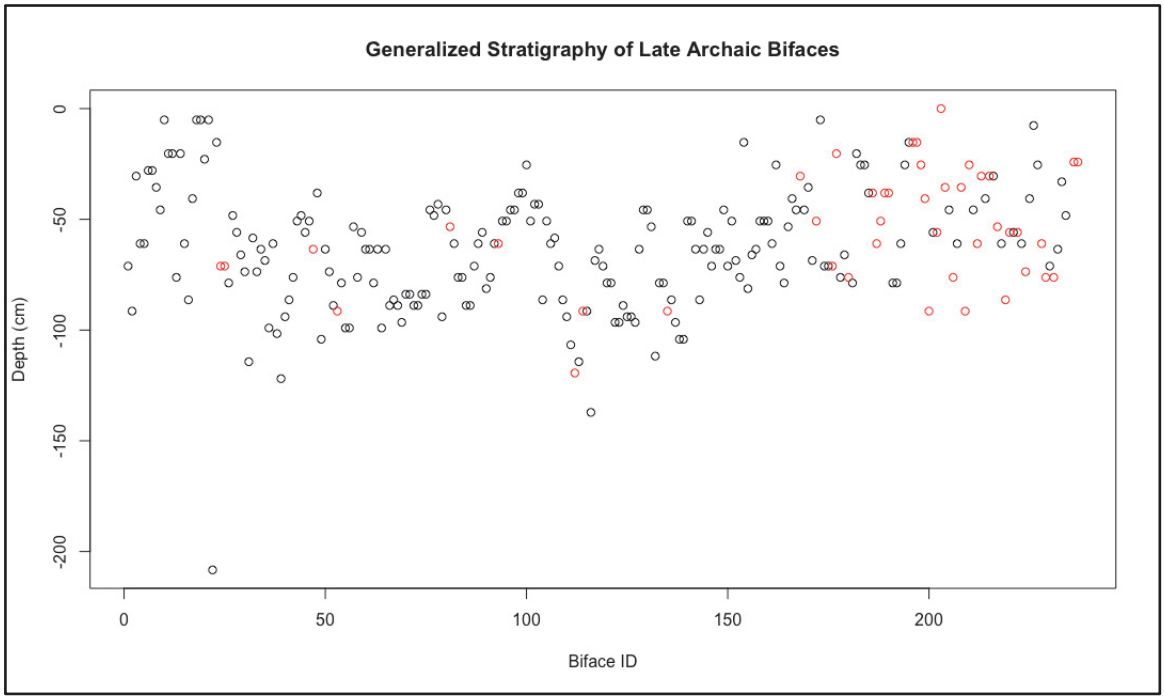


Figure 23: A Generalized Stratigraphy of Finds

As a note, the sample size of bifaces with acceptable depth measurements is approximately half of the total collection. Only 237 of the bifaces had associated depths. The other 257 were removed from the sample (For having either no associated depth data or not associated with the Late Archaic) and recalculated for the PCA which still showed the two-group distinction in question here. The data support an interpretation that this separation of point designs is a product of something other than change of form through time and simply a broader design choice made by contemporaneous people at Lamoka Lake.

Analysis

The dimensions of these bifaces were constrained in three ways as discussed above.

- 87% of the maximum length measurements fall below 10cm.
- 86% of the maximum width measurements fall below 4cm.
- 96% of the thickness measurements fall below 1 cm.

These constraints indicate a very specific idea of how these bifaces were to be shaped. While this most likely was influenced by the size of the starting raw material, chert cobbles, there still appears to be a rough template that the people at Lamoka Lake used for their bifaces. Given this idea of a relatively strict set of dimensions to work within the divide that we see in the morphological variation is still indicative of a design choice made by the producers, more likely on the micro-scale.

What all of these results indicate is that Lamoka Lake was probably a more culturally diverse site than previously assumed. With this indication of difference in hafted biface shape it can be assumed that Lamoka Lake's inhabitants (or visitors) were more diverse than original conception of a homogenous group of hunter-gatherers meeting seasonally at this site. Instead the argument offered here is that in order to create this sort of shape distinction there needed to be at least two separate groups of biface producers who learned in their own CoP, how to build their tools in specific ways.

Within the two clusters in the PCA all examples of the biface types at the site are present on both sides of the divide. Primarily, it is made up of the Lamoka type but there are also other varieties. I suggest that there must have been a specific way that each of these group was constructing their bifaces that crossed the overall design of the tool and

entered into a more specific and identifying production. Following the ideas of CoP it can be assumed that this distinction within categorical types falls into the social constraints on production. Briefly summarized, the CoP concept suggests that it is possible to see the cultural influence on tools made by groups by understanding the three levels of constraints on design (Carr 1996):

1. The technological or the physical constraints of the material used for the tool;
2. The social constraints from the surrounding community; and
3. The individual, familial, and personal choices made.

Within these three levels the two-group distinction, I propose that the distinctions highlighted here (Figures 13, 15, 16, and 17), must fall somewhere between the social/community and the familial constraints. Likely these are present as micro-techniques or choices made in flaking and forming practices rather than broader functional design choices. The results of my research do not necessarily show the familial and this is assumed because the scatterplot is not as dispersed as a plot showing that would be. We could very well be looking at evidence of social divergence in the people of Lamoka Lake.

If the distinction lies more towards the community side then this would be strong evidence that communities smaller than large hunter-gatherer bands were likely starting to produce identifying shapes in their biface production. If the explanation lies more towards the familial then it is more likely that a much larger degree of variation would be present in the bifaces produced at Lamoka Lake. Community level constraints on biface production is subtly indicative of a social distinction that was previously not thought to exist during the Late Archaic in the Northeast.

One other underlying question about this distinction is if it is simply caused by a difference in hafting technique since this distinction lies mostly in the shape of the base. However, the shape of the base is often the aspect with less restrictions on form so it is therefore thought to have more cultural information designed into it (Lipo et al. 2016:176). If it is assumed that the blade or distal end of the biface is the functional end and the assumed function of that end is to pierce a target as a projectile then as long as the tip is functional, the broader shape of the biface tip can vary. Since the divide we see in the collection does not conform with broader typological distinctions then it is likely that there are smaller micro-techniques that are reflected in the shape. Thus the divide that we see in the PCA of the collection likely shows a difference in design choice rather than a difference in functional use.

Through this difference in design choice while remaining within the constraints of the rough template outlined here I suggest that the biface collection from Lamoka Lake shows the presence of at least two distinct groups at the site who design their bifaces, likely with differing micro-techniques, in ways unique to their communities. I do not suggest that these results can tell us what kind of groups these two were but rather that there simply were at least two different groups. What these results can suggest though is that Lamoka Lake may exist because of reasons of social diversification. A large site such as this may have been a periodic aggregation site where scattered groups coalesced and developed cohesiveness partly through their production of bifacial tools. The implications of this conclusion are that we may be seeing the beginnings of social diversification taking place at Lamoka Lake, something that has not been explicitly discussed for Northeastern Late Archaic sites

Chapter 5: Conclusion

The Lamoka Lake Site has been a pivotal site in the development of our understanding of the Late Archaic in the Finger Lakes region of New York as well as the Northeastern United States. When this site was first excavated in the late 1920's, it had a wealth of information to offer. The large number of artifacts and the variety of artifact classes helped Ritchie define an entire era of human occupation in ancient North America. Decades of Late Archaic research has been informed and somewhat directed by the work Ritchie accomplished at this site. Though Lamoka Lake has only been excavated intermittently since Ritchie's initial excavations and the collections only studied a few times, it still has a wealth of information to offer our knowledge of the Late Archaic.

Largely considered an era of seasonally nomadic hunter-gatherers, the Late Archaic of New York has proven to be much more complicated than previously thought (Miroff et al. 2009; Versaggi et al. 2001). The results offered in this thesis further support the likelihood that the region was filled with a greater level of social diversity during the Late Archaic than previously assumed. My findings, as well as those offered by others (Curtin 1999; Madrigal 1999; Miroff et al. 2009; Versaggi et al. 2001) suggest that the widely accepted notion of the Lamoka people as a homogenous pan-regional group of hunter-gatherers has hindered research into the concept of Late Archaic social complexity in the Northeast. Most researchers have simply accepted the assumption that there was no

reason to search for social diversity at sites. With traditional projectile point typologies and broad trait lists that only changed through time in this region, there was no incentive to investigate change within groups and across space.

To infer group diversity from a collection of artifacts I found the tenets of CoP offered. With the assistance of geometric morphometrics and statistical analysis, I was able to show that bifaces found at Lamoka Lake were formed in at least two different fashions; likely representing the presence of at least two groups during the Late Archaic. These two groups did not line up with any previously determined distinguishing factors and this point was further supported by statistical results showing non-randomness.

I used a relatively new method to collect the morphological data because of advancements in the fields of computers and photography. Since I was able to use the camera built into my iPhone to capture the shape of these bifaces, this method has proven to be a versatile and easily replicable approach. While this method cannot capture all three dimensions of an object, its ability to capture the two-dimensional shape of the bifaces is powerful and can be applied to quite a few other artifact forms often found in the archaeological record.

The results of this project can be simply summed up with the statement that there is evidence of at least two groups at Lamoka Lake. What these groups represent is not known from this study but it could be suggested that they are social divisions, possibly representing different regional communities, or intra-group CoP. A rough template used to produce bifaces was reflected in the dimensional constraints found on all bifaces studied. The two resulting statistical clusters suggested that these two groups were aiming to create a similar biface but went about it in two different ways. The possibility that a

site like Lamoka Lake could have provided the venue for development of social cohesion partly through biface production suggests that more research should be focused on similar Late Archaic sites to see if they present similar evidence.

Over the last few decades the discussion of hunter-gatherers in the Late Archaic Eastern Woodlands has been shifting. Moving away from the static model of hunter-gatherers research has found both social diversity and relative sedentism among the Late Archaic peoples from the Southeast all the way up to the Northeast as well as some of the way into the Midwest (Anderson 1995; Franklin et al. 2010; Madrigal 1999; Miroff et al. 2009; Pagoulatos 2009; Sassaman 2010; Versaggi et al. 2001). This shift in our understanding of the Late Archaic is important because its suggests more fluidity in human development. In a broader context my research has added to the social complexity of the Northeast, where before it was generally assumed to not exist or not exist yet, helping us to better understand the path that humans took while carving out a place in the region.

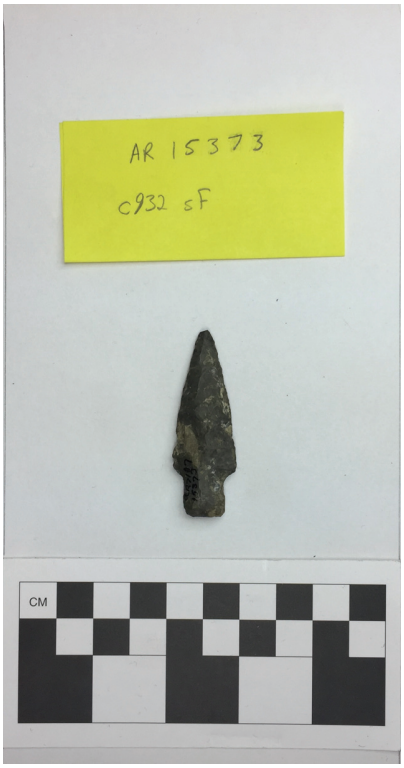
Future Research

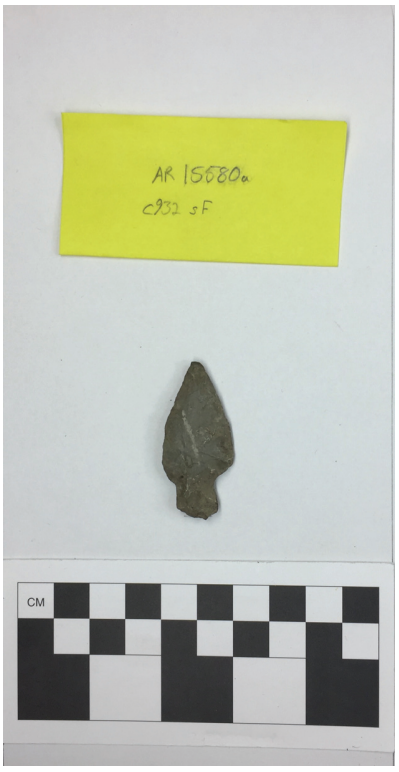
Future research on this subject will need to take many forms in order to further support the argument that Lamoka consists of diverse groups. This will obviously not be an exhaustive list of future research possibilities. A detailed microwear analysis of the bifaces in question will need to be done in order to identify more patterns that could better explain how these tools were produced. If the collection does include debitage left over from manufacture, those artifacts will need to be examined and analyzed to further add to our understanding of how these points were produced. Conducting a more detailed contextual analysis of where each of these bifaces (and debitage if it exists) occurs on the

site could help explain how they were using the site and possibly suggest a spatial difference in the groups lived. Another avenue of future research could be to return to Lamoka Lake and conduct geophysical survey to determine house patterns and finding unexplored features and artifacts that can further indicate the extent of occupation. Excavations to gather new data could also be conducted that can be more tightly controlled for context than the current collection.

Lamoka Lake is an important Late Archaic site in the Finger Lakes Region of New York. It was the birthplace of an entire conception of hunter-gatherer populations on this continent and has informed our thinking about the past for almost a century. The fact that it still has much knowledge to offer us should be no surprise and I think that we should be considering new ways to explore and study this site.

Appendix A: Biface Photographs

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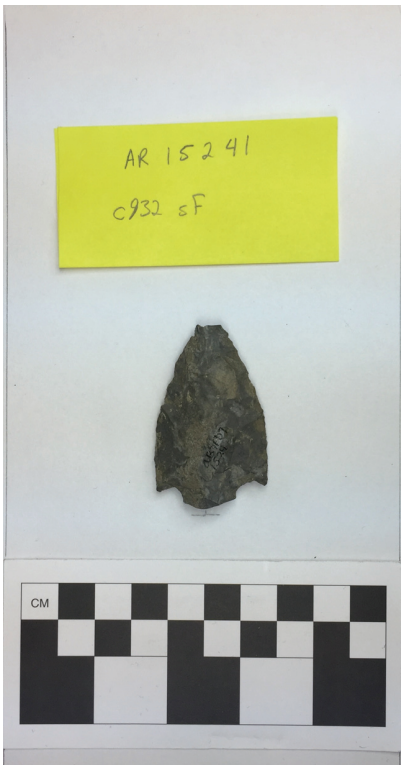
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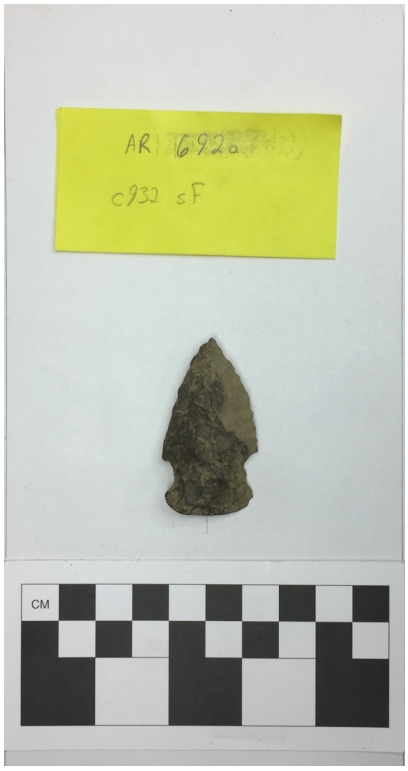
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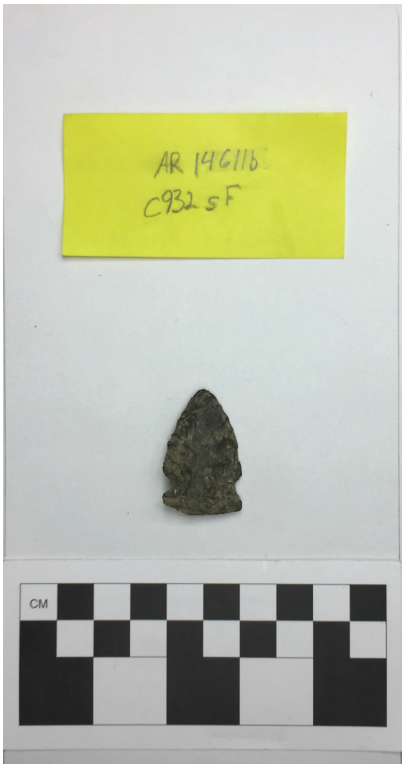
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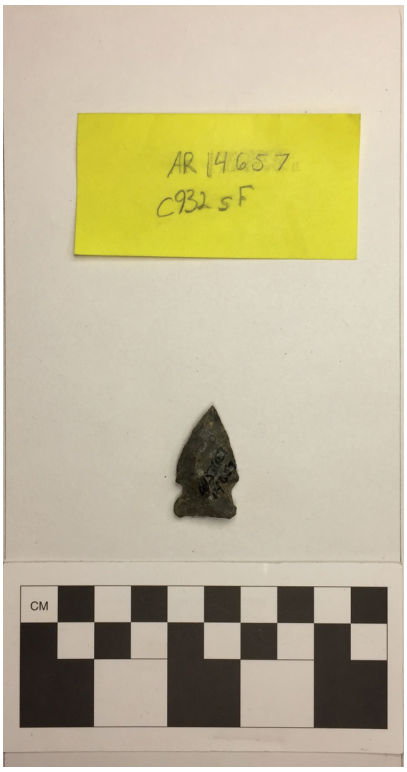
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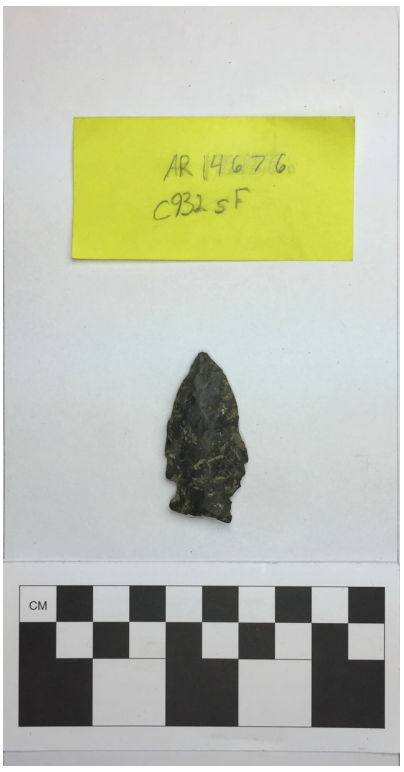
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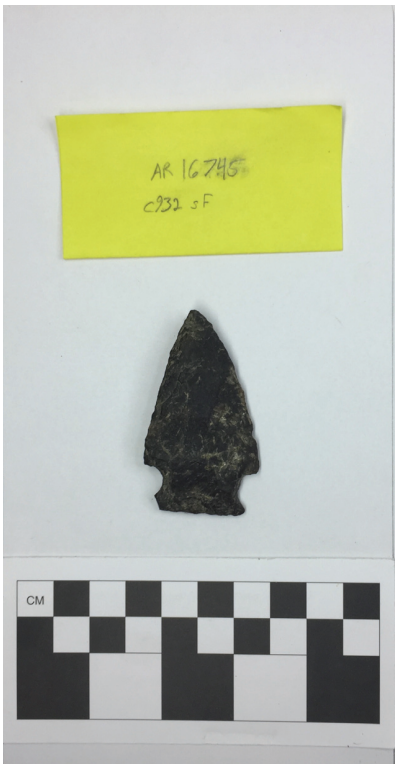
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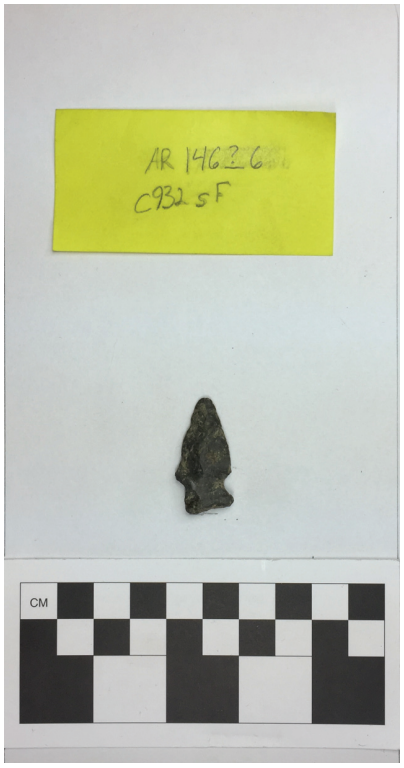
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AR 2086(?) 6 or 2
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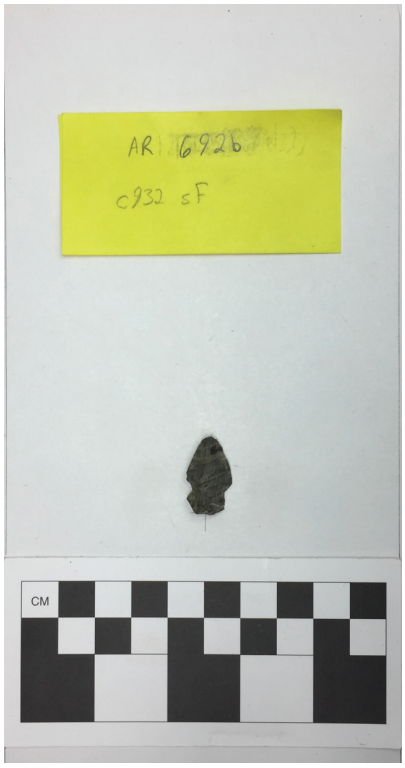
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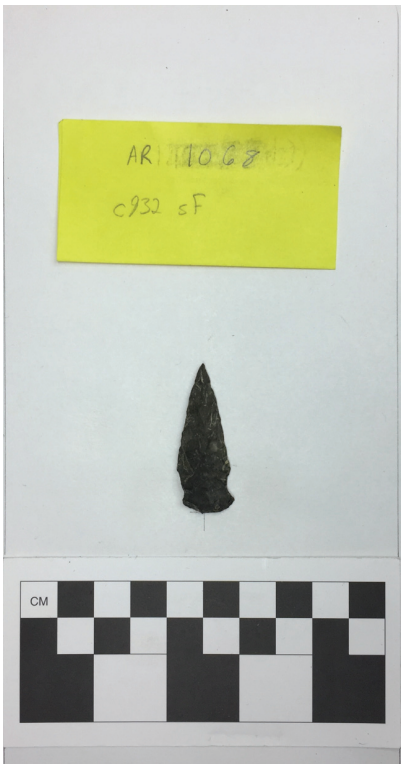
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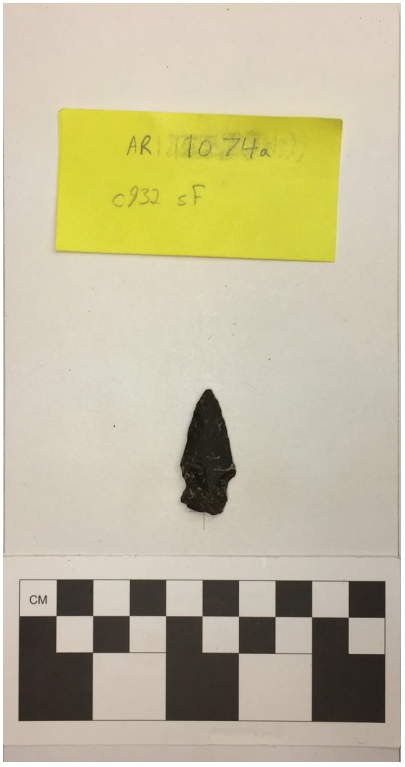
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AR 1079
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AR 1080
C932 sF
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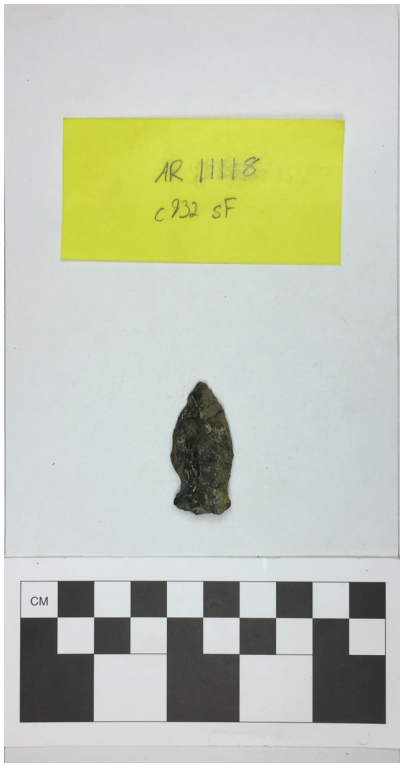
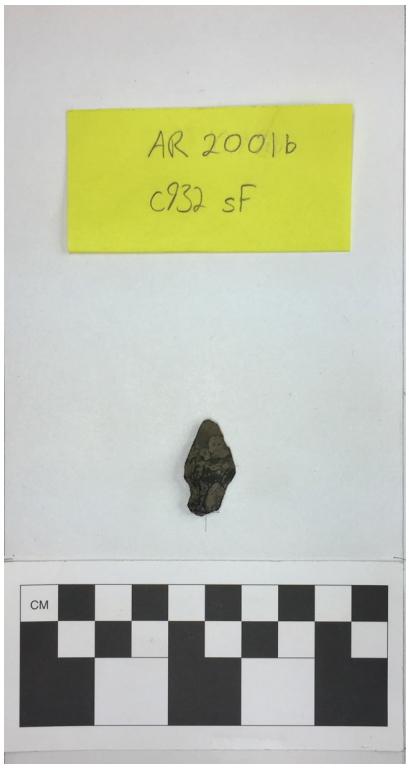
AR 1096
C932 sF
CM


AR 1097
c932 sF
CM


AR 1098a
c932 sF
CM


AR 1098b
c932 sF
CM


AR 1111B
c932 sF
CM


AR 2001b
C932 sF
CM


AR 2002a
C932 sF
CM


AR 2002b
C932 sF
CM


AR 2002c
C932 sF
CM


AR 2003
C932 sF
CM


AR 2005
C932 sF
CM


AR 2008
C932 sF
CM


AR 2009
C932 sF
CM


AR 2010
C932 sF
CM


AR 2011
C932 sF
CM


AR 2013
C932 sF
CM


AR 2015
C932 sF
CM


AR 2016
C932 sF
CM


AR 2019
C932 sF
CM

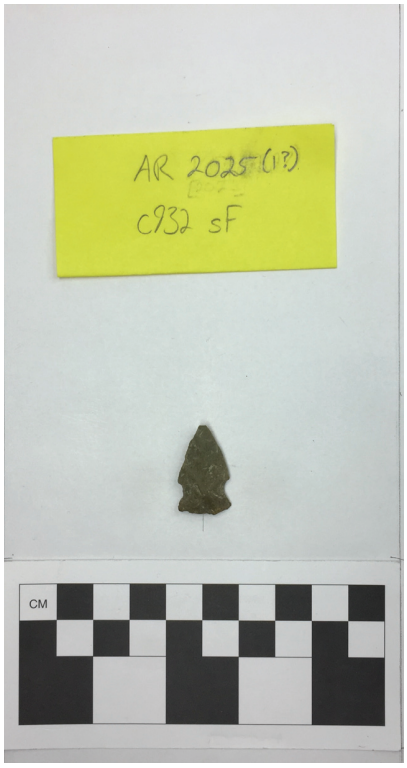

AR 2020
C932 sF
CM


AR 2021
C932 sF
CM


AR 2023
C932 sF
CM


AR 2023
C932 sF
CM


AR 2024b
C932 sF
CM

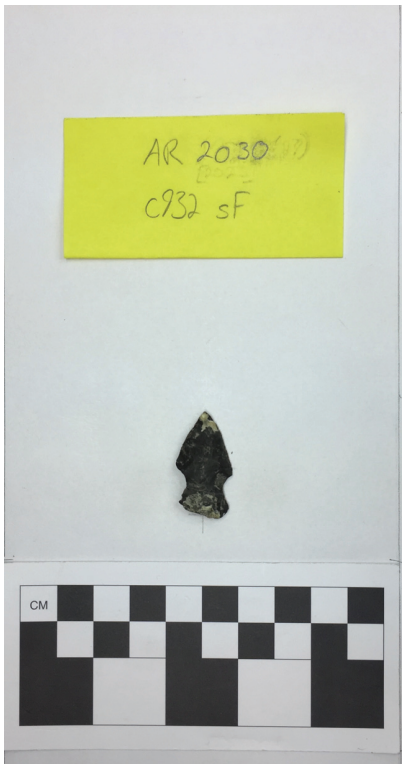

AR 2025(1?)
C932 sF
CM

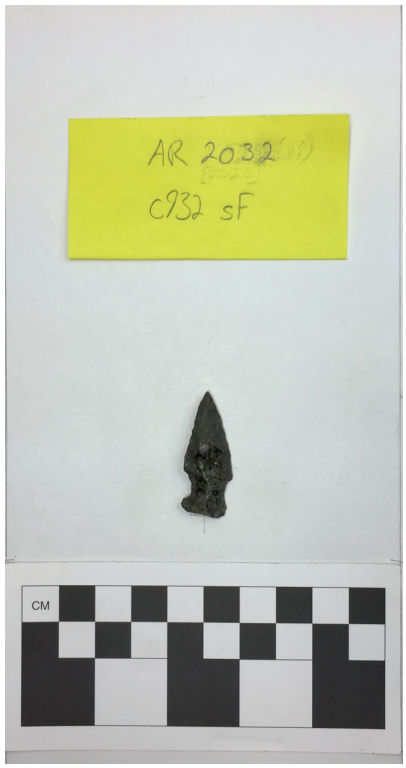

AR 2025
C932 sF
CM


AR 2027
C932 sF
CM

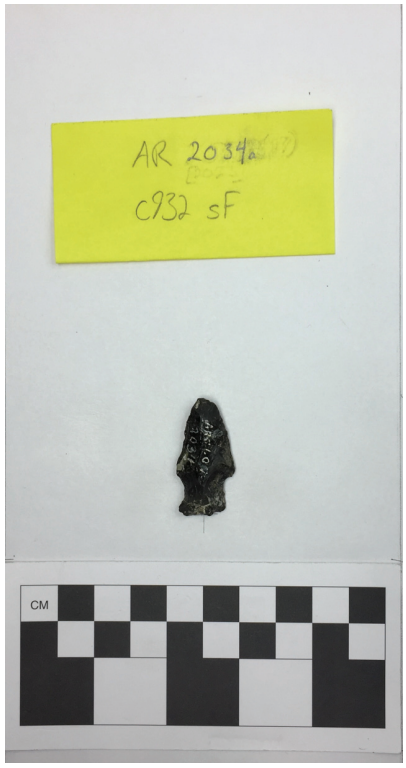

AR 2028
C932 sF
CM


AR 2028
C932 sF
CM

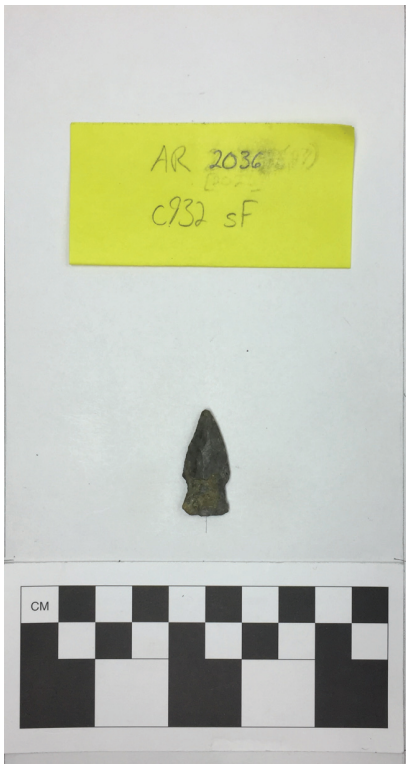

AR 2030
C932 sF
CM

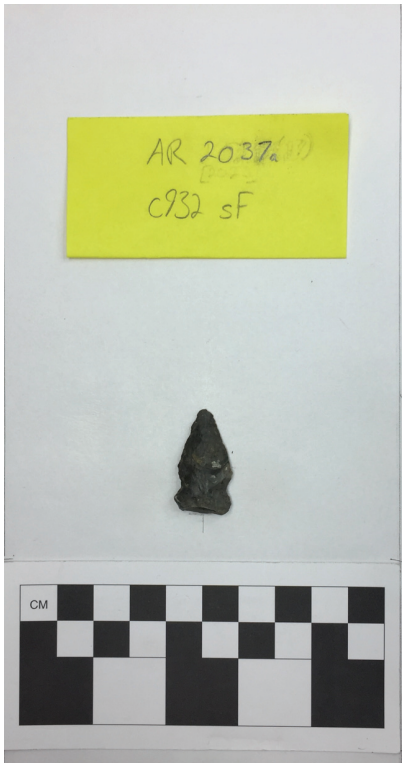

AR 2032
C932 sF
CM

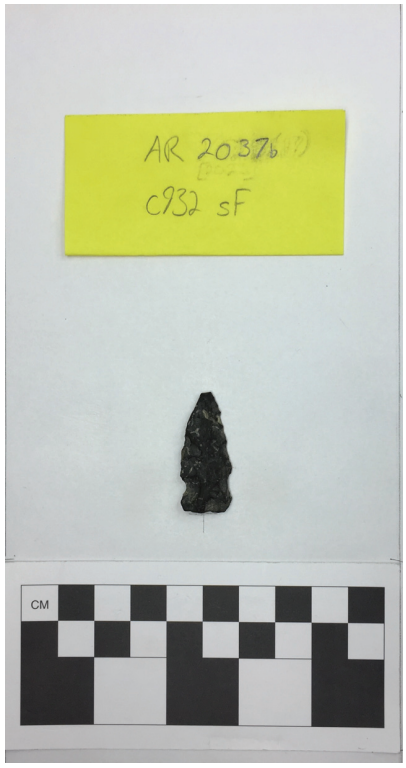

AR 2033
C932 sF
CM

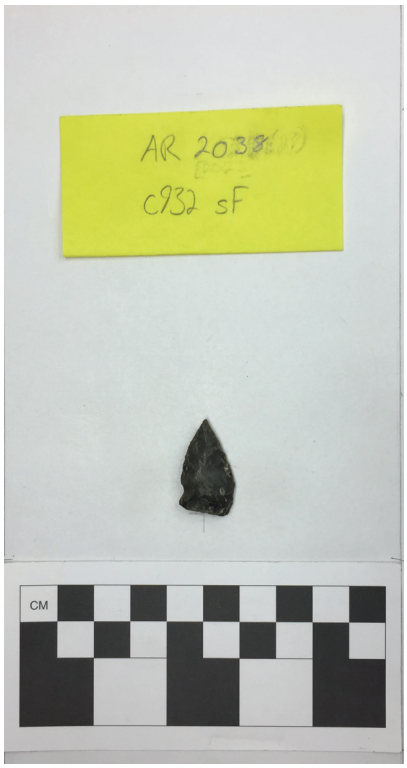

AR 2034
C932 sF
CM

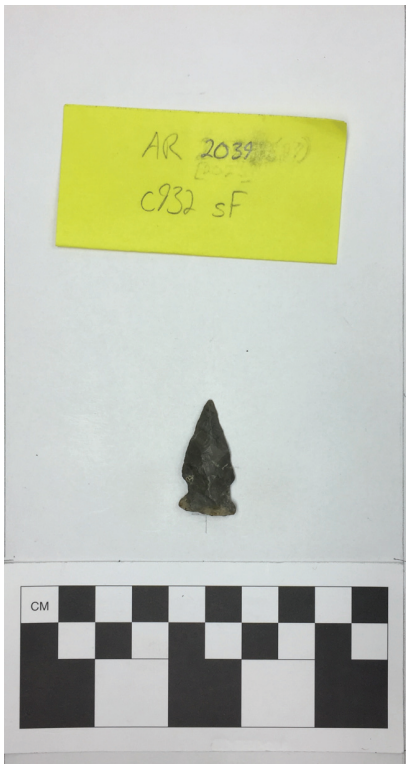

AR 2034b
C932 sF
CM


AR 2036
C932 sF
CM


AR 2037a
C932 sF
CM

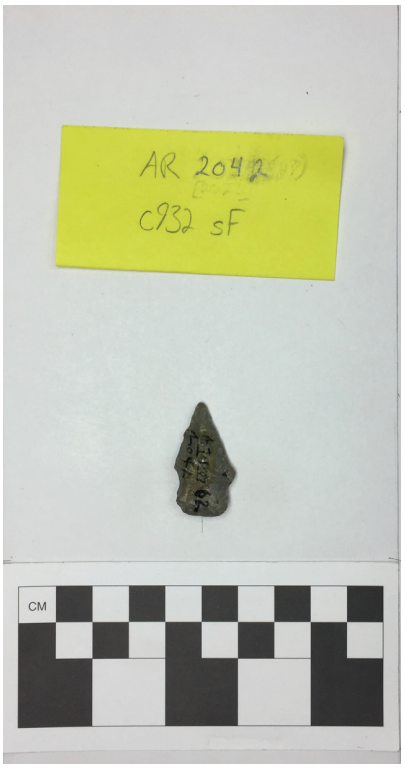

AR 2037b
C932 sF
CM

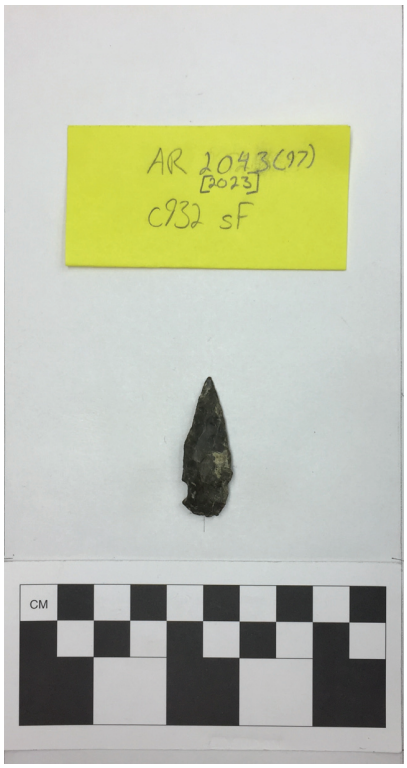

AR 2038
C932 sF
CM


AR 2039
C932 sF
CM

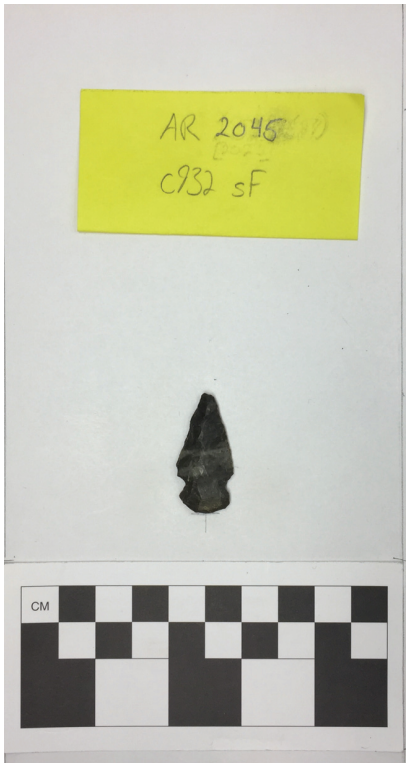

AR 2039
C932 sF
CM

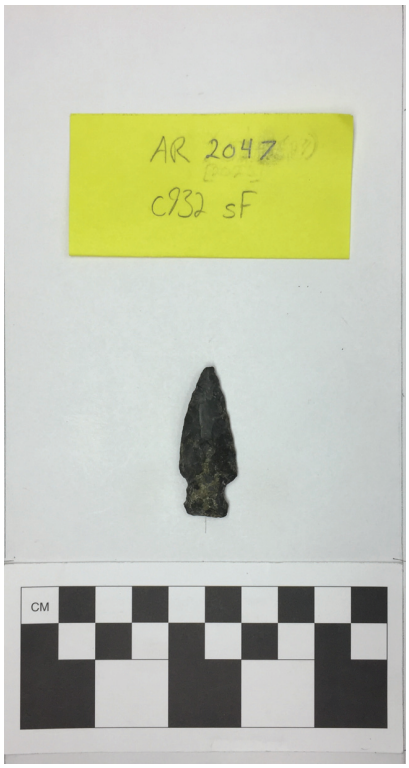

AR 2040
C932 sF
CM

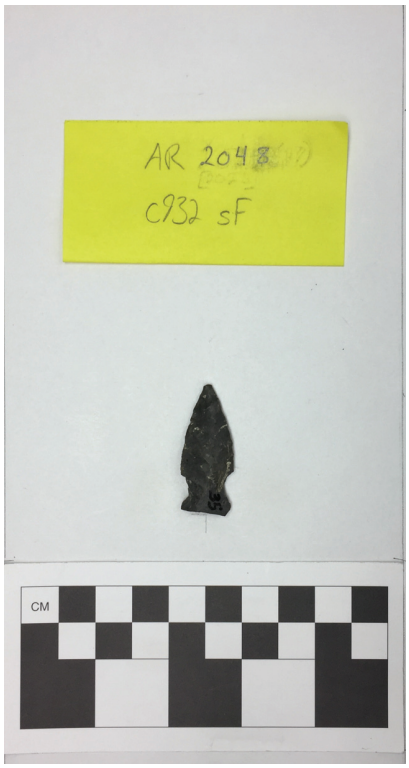

AR 2042
C932 sF
CM


AR 2043(97)
[2023]
C932 sF
CM


AR 2044
C932 sF
CM


AR 2045
C932 sF
CM


AR 2047
C932 sF
CM


AR 2048
C932 sF
CM


AR 2049
C932 sF
CM


AR 2051
C932 sF
CM


AR 2052
C932 sF
CM


AR 2053
C932 sF
CM


AR 2054
C932 sF
CM


AR 2055
C932 sF
CM


AR 2057
C932 sF
CM


AR 2059
C932 sF
CM


AR 2060
C932 sF
CM

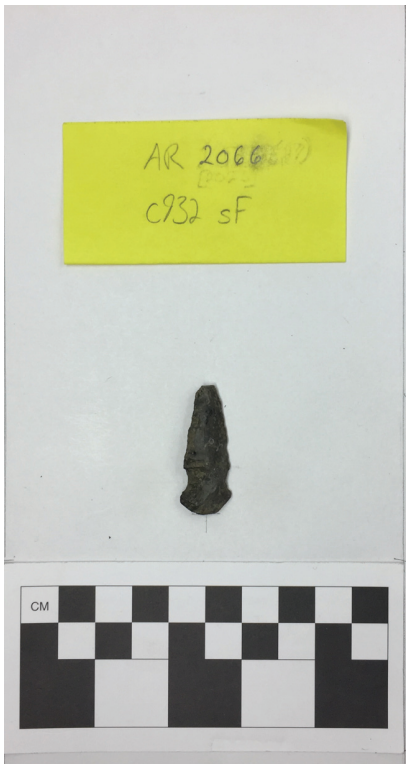

AR 2061
C932 sF
CM

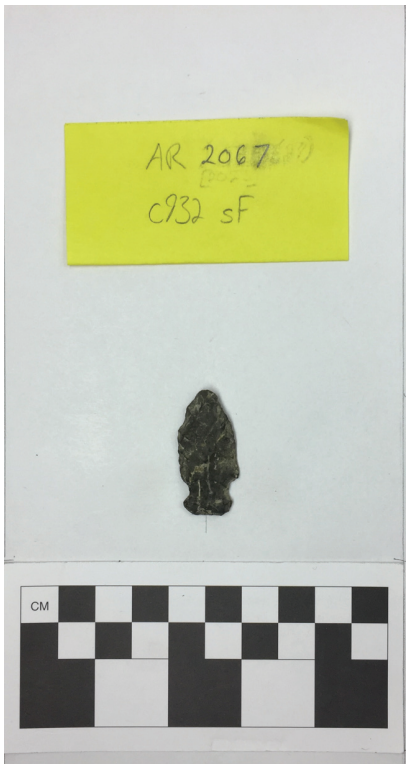

AR 2062
C932 sF
CM

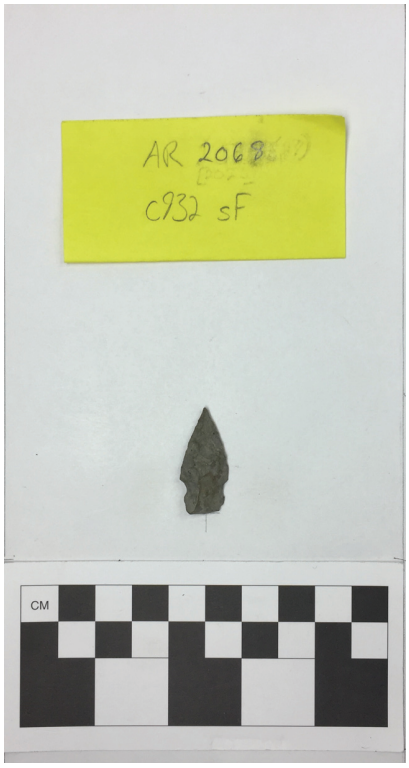

AR 2063
C932 sF
CM


AR 2064
C932 sF
CM

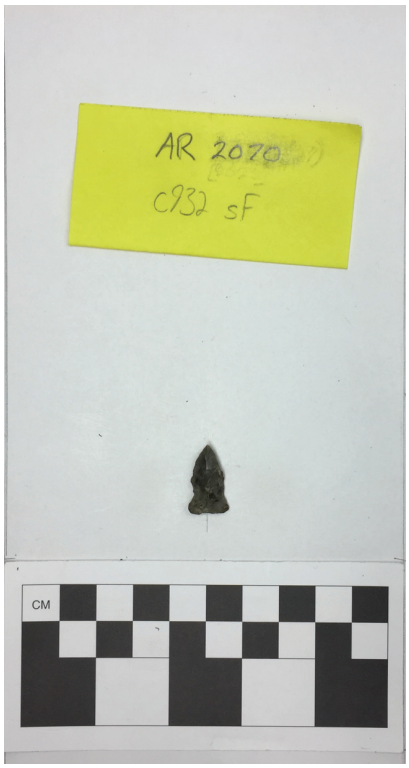

AR 2065
C932 sF
CM


AR 2066
C932 sF
CM


AR 2067
C932 sF
CM

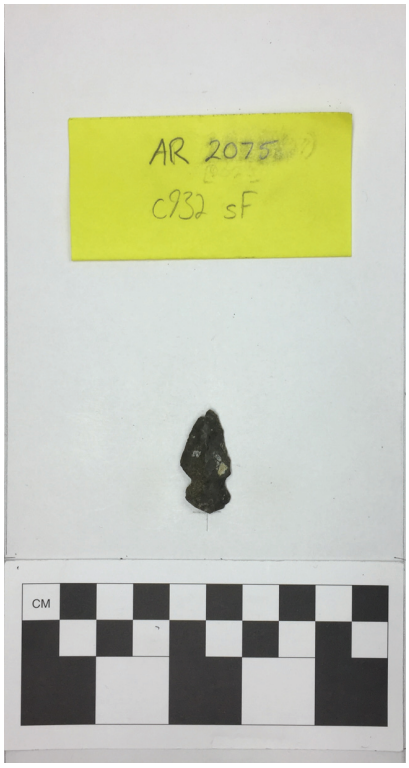

AR 2068
C932 sF
CM


AR 2069
C932 sF
CM


AR 2070
C932 sF
CM


AR 2072
C932 sF
CM


AR 2073
C932 sF
CM


AR 2075
C932 sF
CM


AR 2076
C932 sF
CM


AR 2078
C932 sF
CM


AR 2082
C932 sF
CM


AR 2083
C932 sF
CM


AR 2085
C932 sF
CM


AR 2086
C932 sF
CM


AR 2087
C932 sF
CM


AR 2088
C932 sF
CM


AR 2089
C932 sF
CM


AR 2090
C932 sF
CM


AR 2094
C932 sF
CM


AR 2096
C932 sF
CM


AR 2097
C932 sF
CM


AR 2098
C932 sF
CM


AR 2098
C932 sF
CM


AR 2099
C932 sF
CM


AR 20996
C932 sF
CM

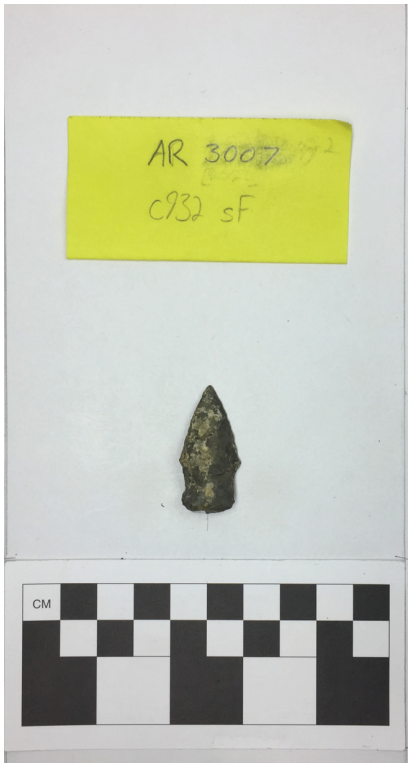

AR 3000
C932 sF
CM


AR 3002
C932 sF
CM


AR 3004
C932 sF
CM


AR 3006a
C932 sF
CM


AR 3006b
C932 sF
CM

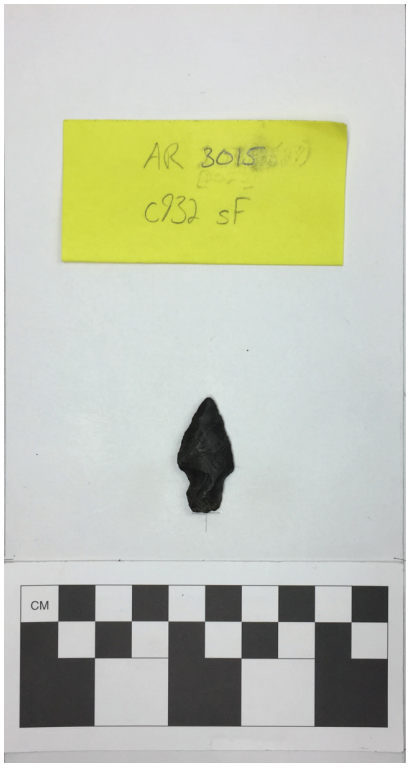

AR 3007
C932 sF
CM


AR 3008
C932 sF
CM


AR 3007
C932 sF
CM


AR 3010
C932 sF
CM


AR 3014
C932 sF
CM


AR 3015
C932 sF
CM


AR 3016
C932 sF
CM


AR 3018
C932 sF
CM


AR 3019
C932 sF
CM

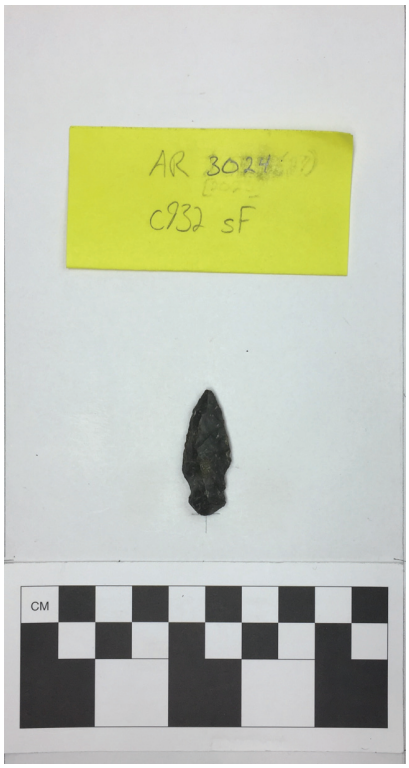

AR 3020
C932 sF
CM


AR 3021
C932 sF
CM


AR 3022
C932 sF
CM

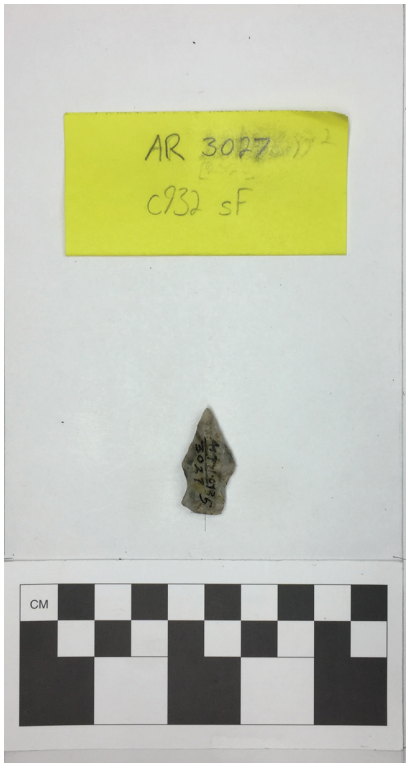

AR 3023
C932 sF
CM

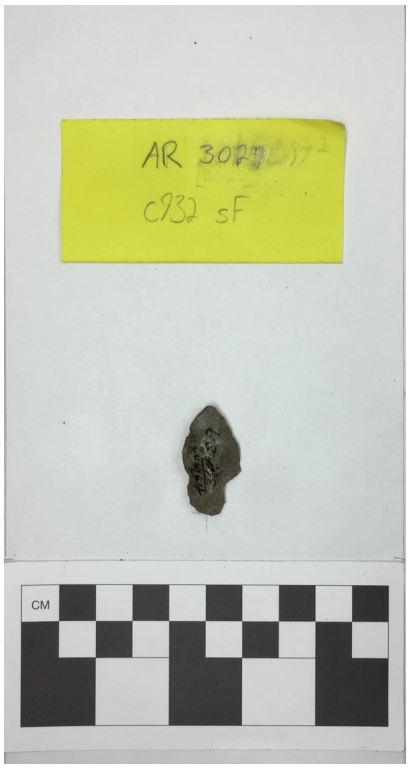

AR 3024
C932 sF
CM


AR 3024
C932 sF
CM


AR 3025
C932 sF
CM

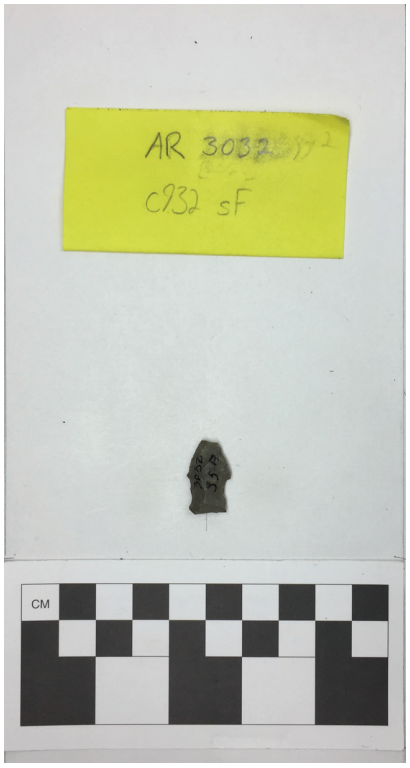

AR 3026
C932 sF
CM


AR 3027
C932 sF
CM


AR 3029
C932 sF
CM


AR 3030
C932 sF
CM


AR 3031
C932 sF
CM


AR 3032
C932 sF
CM


AR 3033
c932 sF
CM


AR 4056 (4050)
c932 sF
CM


AR 4605
c932 sF
CM

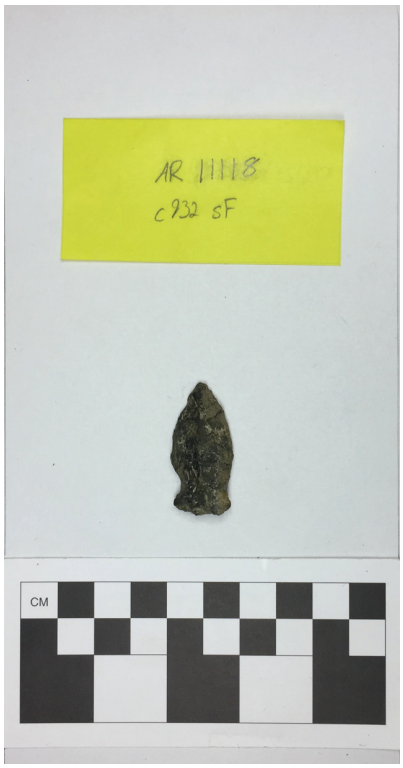

AR 4717
c932 sF
CM


AR 4848
c932 sF
CM


AR 9037
c932 sF
CM


AR 9050
c932 sF
CM


AR 10754
c932 sF
CM


AR 11118
c932 sF
CM


AR 11269 / 16479
c932 sF
CM


AR 12329
c932 sF
CM


AR 12620
c932 sF
CM


AR 13248
c932 sF
CM


AR 13600 / 15600
c932 sF
CM


AR 13612 / 14612
c932 sF
CM


AR 13713
c932 sF
CM


AR 13883
c932 sF
CM


AR 14003
c932 sF
CM


AR 14146
c932 sF
CM


AR 14211
C932 sF
CM


AR 14303
c932 sF
CM


AR 14312
c932 sF
CM


AR 14340
C932 sF
CM


AR 14458
C932 sF
CM


AR 14502
C932 sF
CM


AR 14504
C932 sF
CM


AR 14505
C932 sF
CM


AR 14603
C932 sF
CM


AR 14604
C932 5F
CM


AR 14607
C932 5F
CM


AR 14609
C932 5F
CM


AR 14611a
C932 5F
CM

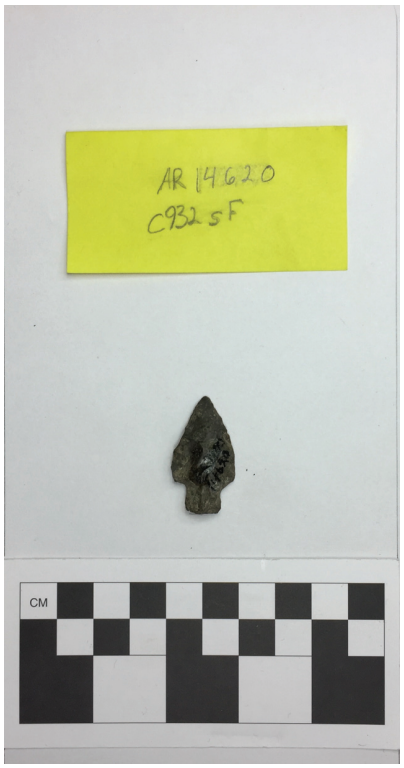

AR 14G13
C932 5F
CM

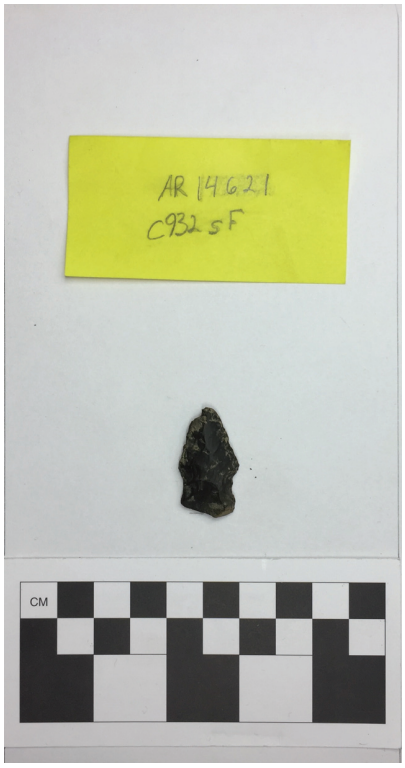

AR 14G14
C932 5F
CM


AR 14G15
C932 5F
CM


AR 14G16
C932 5F
CM

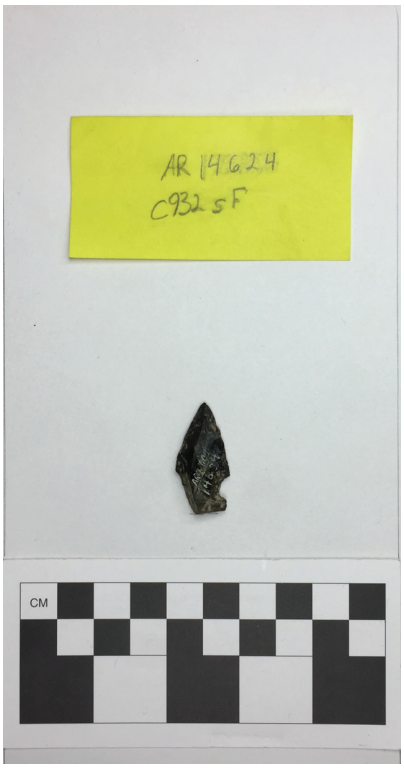

AR 14618
C932 5F
CM


AR 14620
C932 5F
CM


AR 14621
C932 5F
CM

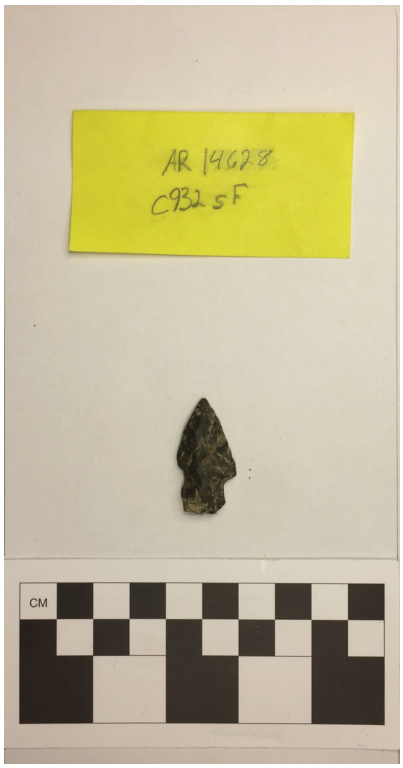

AR 14622
C932 5F
CM


AR 14623
C932 5F
CM

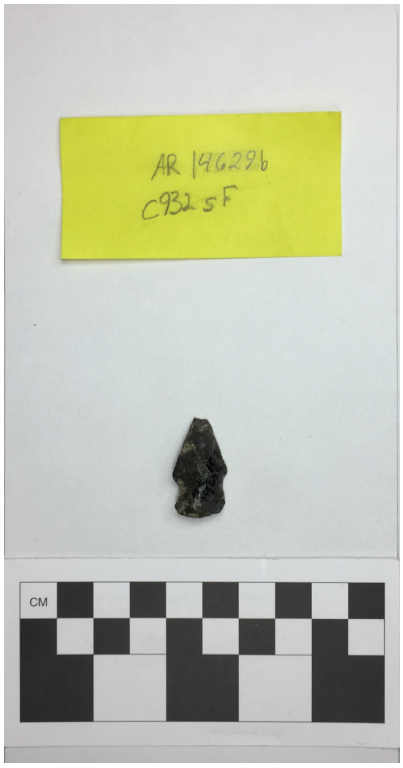

AR 14624
C932 5F
CM


AR 14626
C932 5F
CM

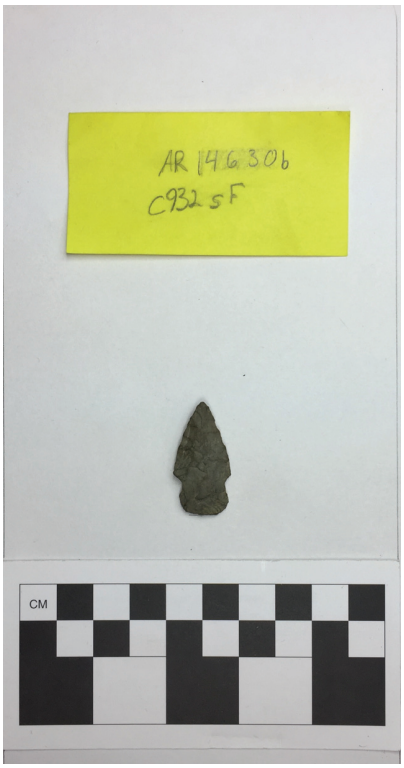

AR 14627
C932 5F
CM


AR 14628
C932 5F
CM


AR 14629a
C932 5F
CM


AR 14629b
C932 5F
CM


AR 14630a
C932 5F
CM

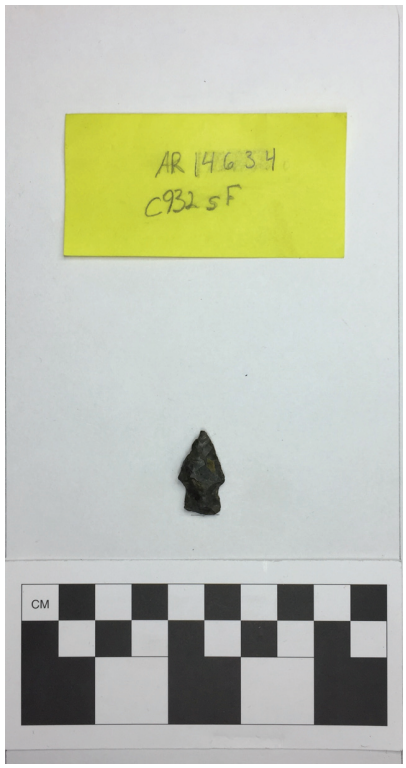

AR 14G30b
C932 5F
CM


AR 14G32
C932 5F
CM


AR 14G32a
C932 5F
CM


AR 14G32b
C932 5F
CM


AR 14633
C932 sF
CM


AR 14634
C932 sF
CM


AR 14635
C932 sF
CM


AR 14635
C932 sF
CM


AR 14643
C932 5F
CM


AR 14643
C932 5F
CM


AR 14645a
C932 5F
CM


AR 14645b
C932 5F
CM


AR 14:646
C932 5F
CM


AR 14:647
C932 5F
CM


AR 14:648
C932 5F
CM


AR 14:649
C932 5F
CM

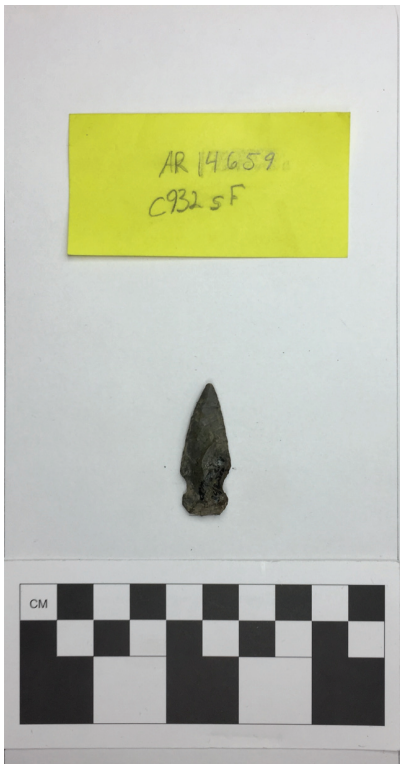

AR 14653a
C932 sF
CM


AR 14653b
C932 sF
CM


AR 14654a
C932 sF
CM


AR 14654b
C932 sF
CM


AR 14656
C932 5F
CM


AR 14659
C932 5F
CM


AR 14660
C932 5F
CM


AR 14662
C932 5F
CM


AR 14664
C932 5F
CM

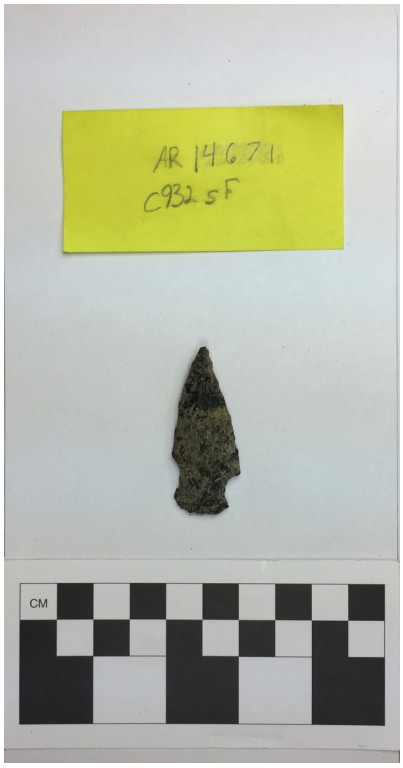

AR 14665a
C932 5F
CM


AR 14665b
C932 5F
CM


AR 14667
C932 5F
CM


AR 14 6 69
C932 5F
CM


AR 14 6 70
C932 5F
CM


AR 14 6 71
C932 5F
CM


AR 14 6 73
C932 5F
CM


AR 14674
C932 5F
CM


AR 14675
C932 5F
CM


AR 14678
C932 5F
CM


AR 14680
C932 5F
CM


AR 14681a
C932 5F
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AR 14681b
C932 5F
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AR 14683
C932 5F
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AR 14680
C932 5F
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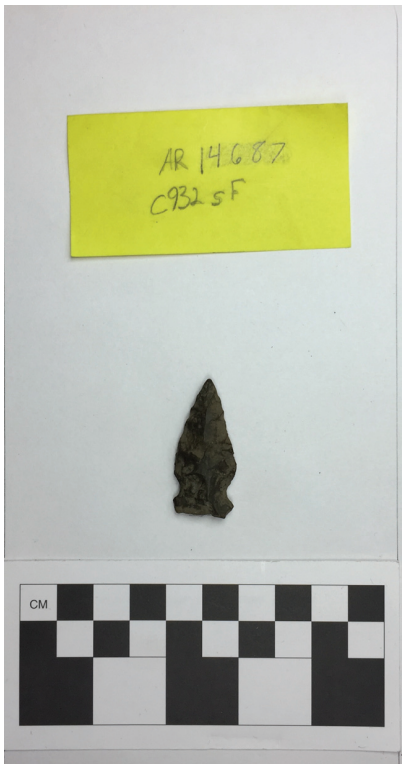
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AR 14689
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AR 14690a
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AR 14690b
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AR 14694a
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AR 14694b
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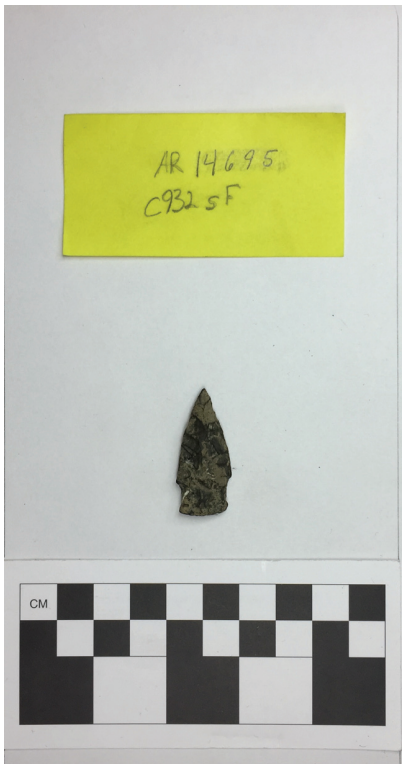
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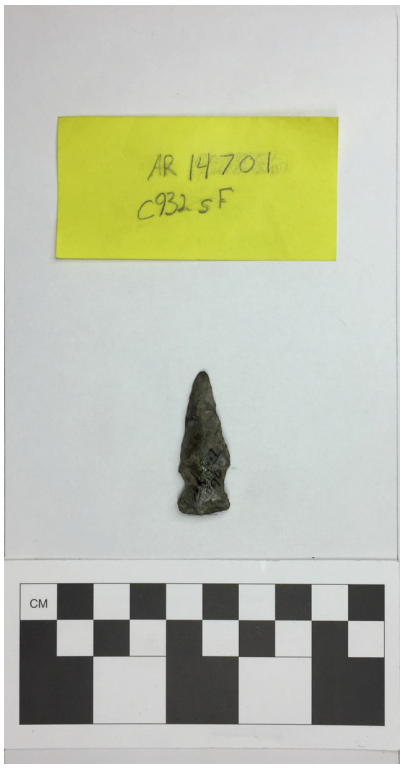
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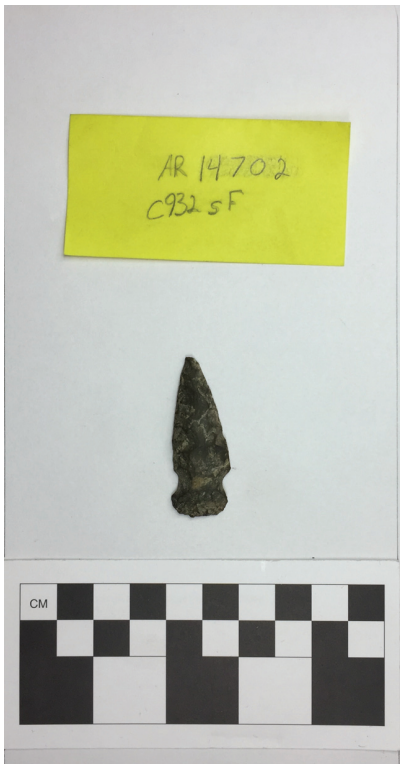
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AR 14708
C932 5F
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AR 14710a
C932 sF
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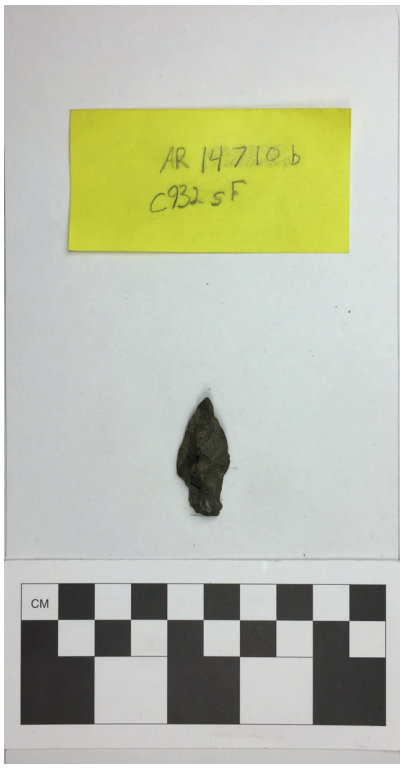
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AR 14713
C932 sF
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AR 14.7.14
C932 5F
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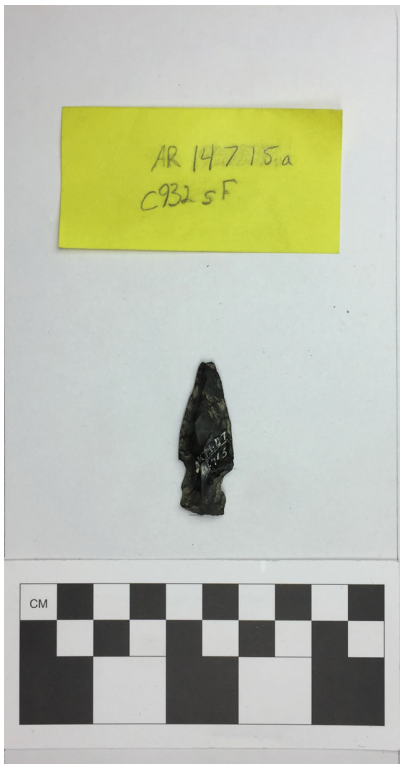
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AR 14.7.15.b
C932 5F
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AR 14.7.24
C932 5F
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AR 147.28a
C932 5F
CM


AR 147.30
C932 5F
CM


AR 147.32
C932 5F
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AR 147.34
C932 5F
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AR 147.35
C932 5F
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AR 147.36
C932 5F
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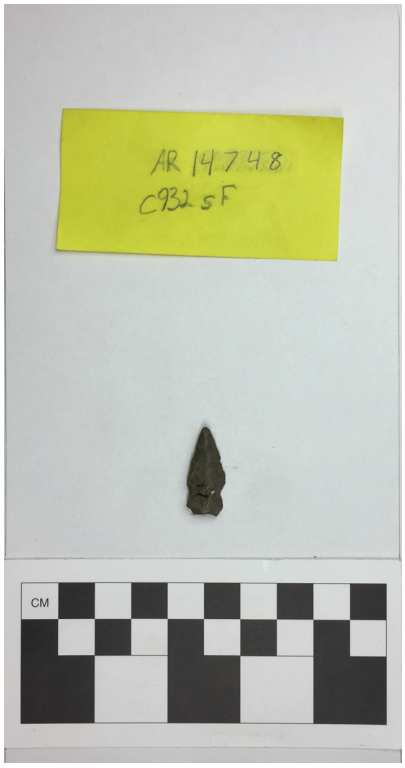
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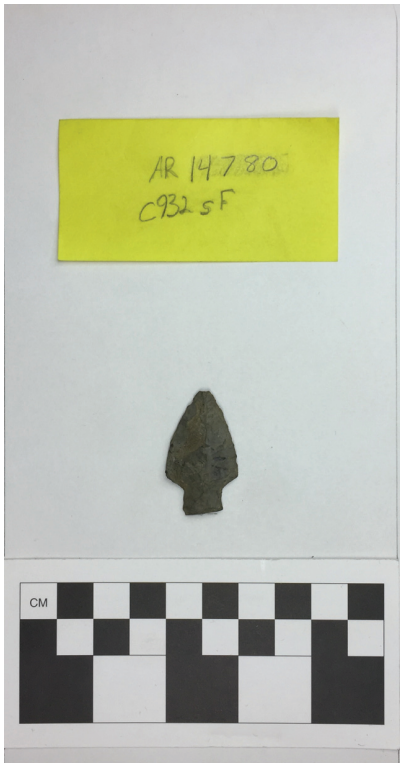
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C932 5F
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AR 14 78
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AR 14 808
C932 5F
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AR 14 829
C932 5F
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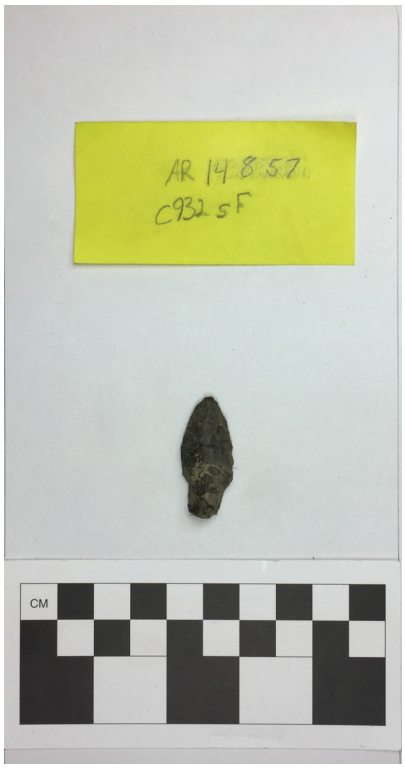
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AR 14 8 68
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AR 14 9 12
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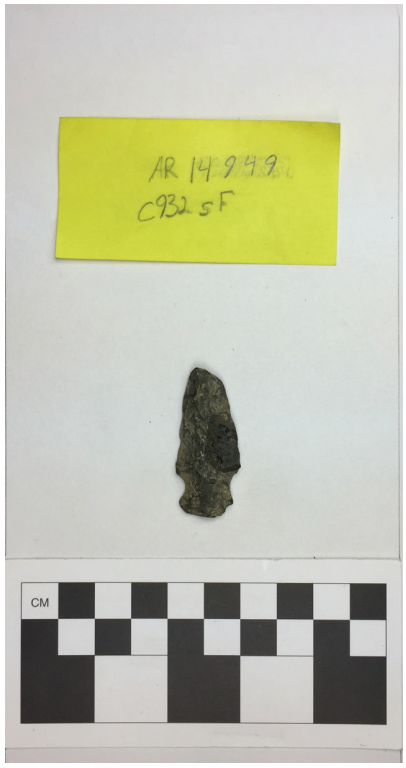
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AR 14972
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AR 14973
C932 sF
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AR 150136
C932 sF
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AR 150136
C932 sF
CM


AR 15026
c932 sF
CM


AR 15040
c932 sF
CM


AR 15064
c932 sF
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AR 15076
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AR 15080
C932 sF
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AR 15093
C932 sF
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AR 15101
C932 sF
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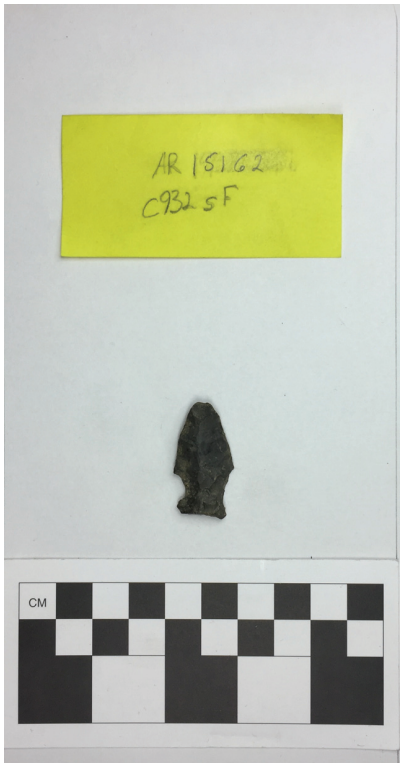
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AR 15166
C932 5F
CM


AR 15195
C932 5F
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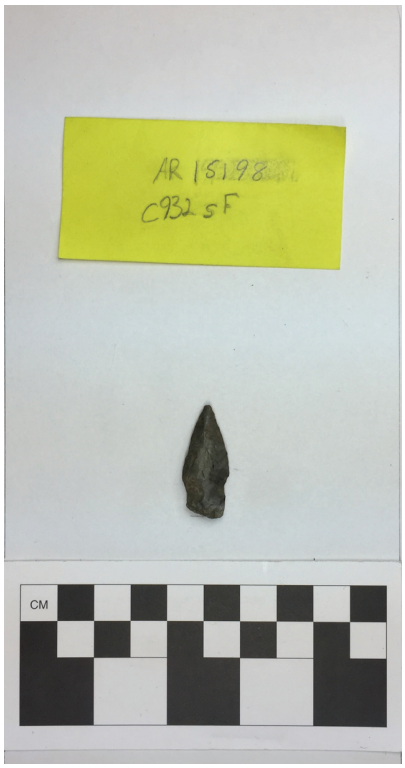
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AR 15267
C932 5F
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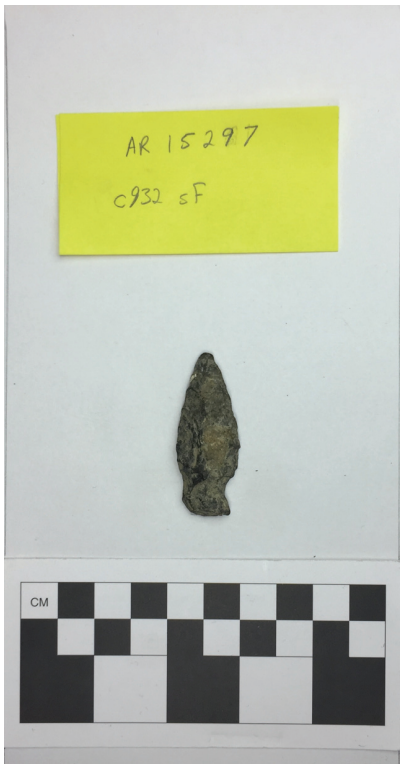
AR 15297
c932 sF
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AR 15307
c932 sF
CM


AR 15315
c932 sF
CM


AR 15329
c932 sF
CM


AR 15377
c932 sF
CM


AR 15385c
c932 sF
CM


AR 15385d
c932 sF
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AR 15391
c932 sF
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AR 15397
c932 sF
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AR 15419
c932 sF
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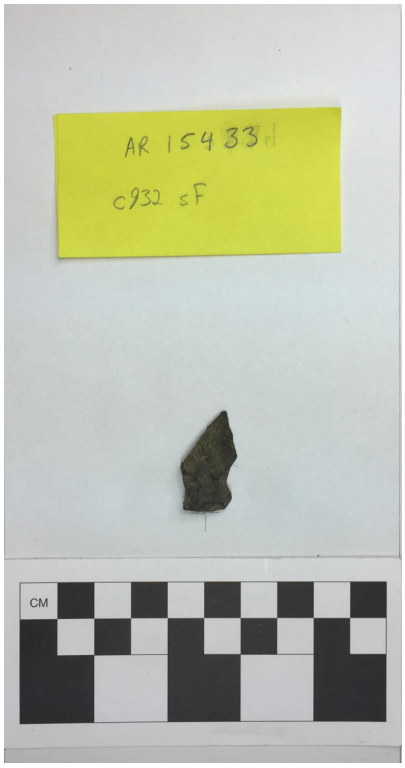
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c932 sF
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AR 15448
c932 sF
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AR 15466
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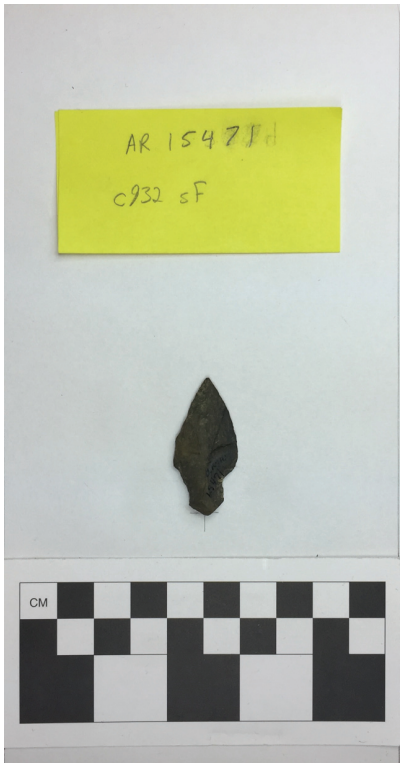
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c932 sF
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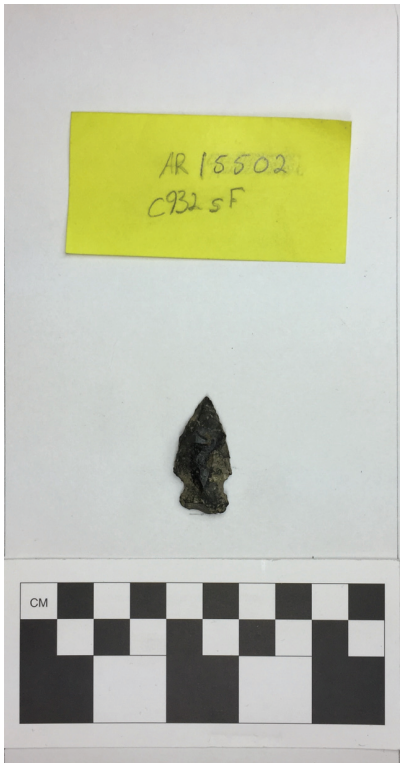
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AR 15505
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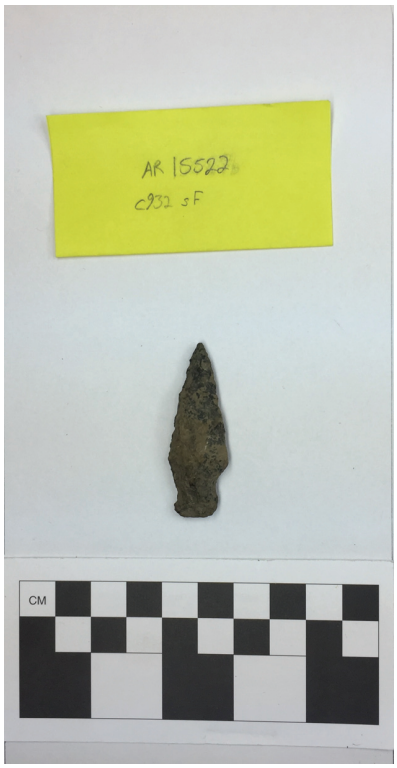
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c932 sF
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c932 sF
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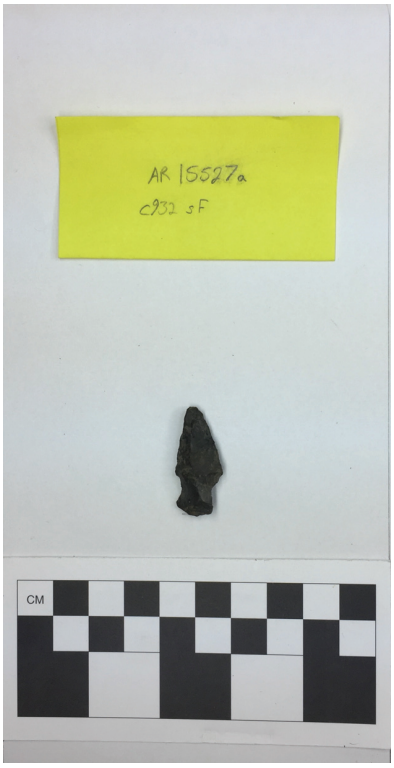
AR 15527a
c932 sF
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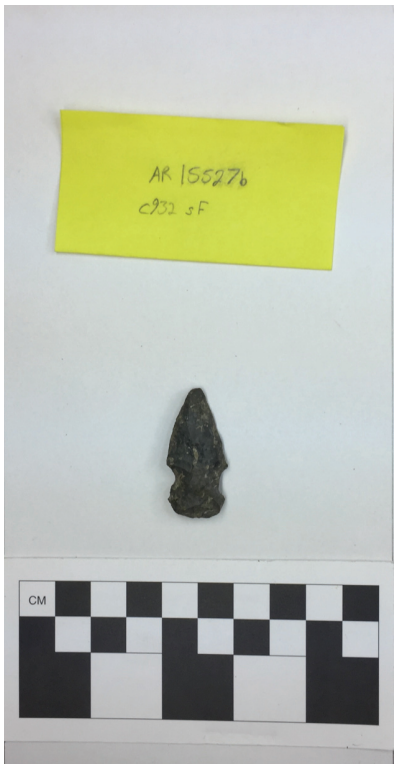
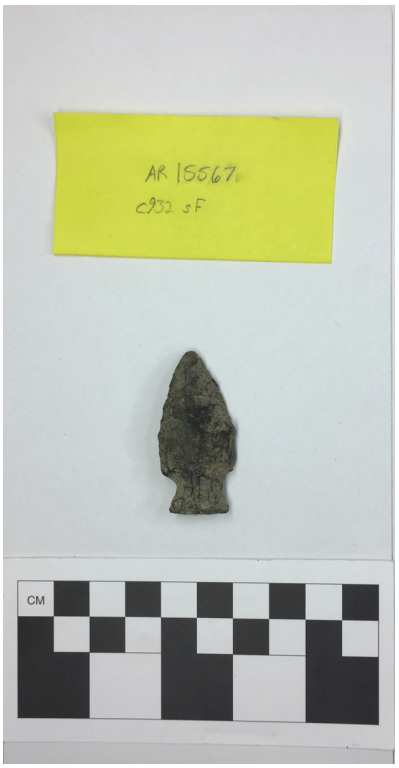

AR 15527b
C932 sF
CM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C932 sF
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AR 15574
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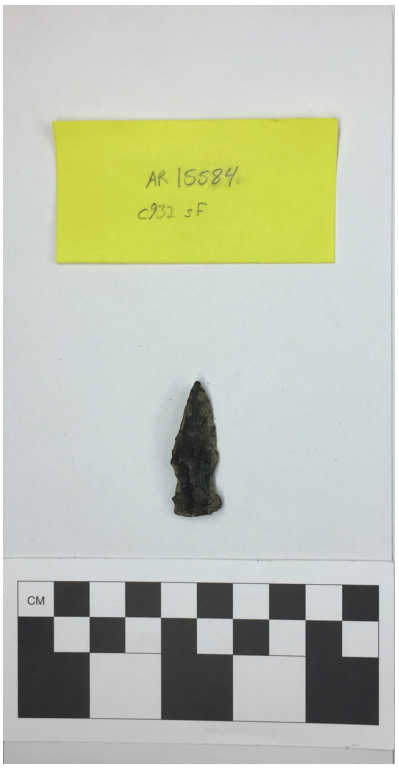
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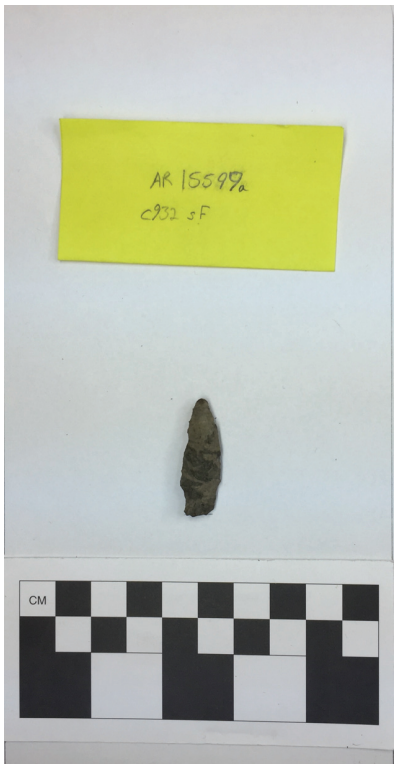
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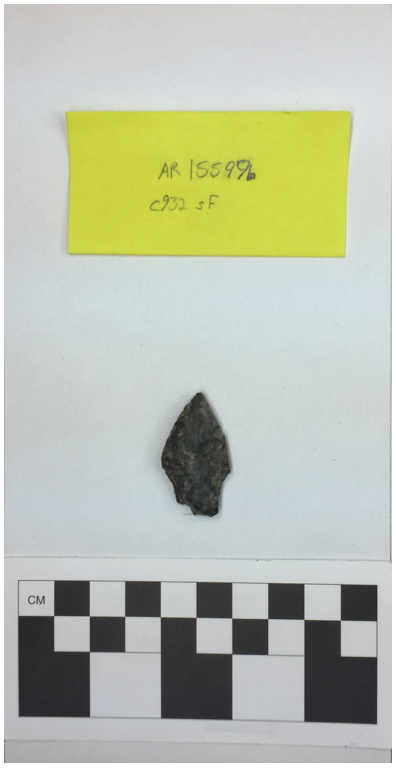
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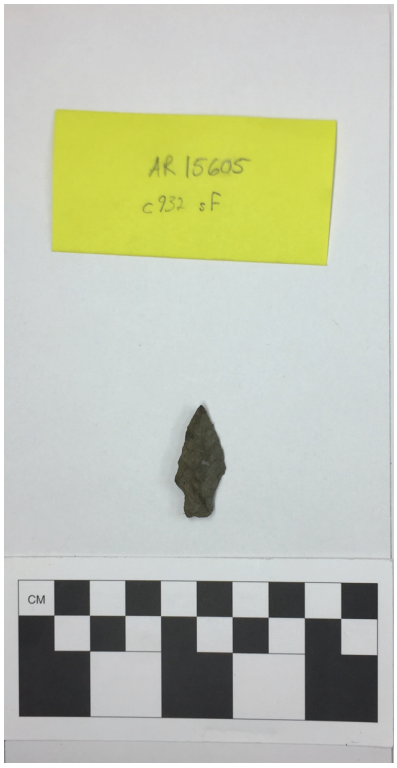
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AR 15619
c932 sF
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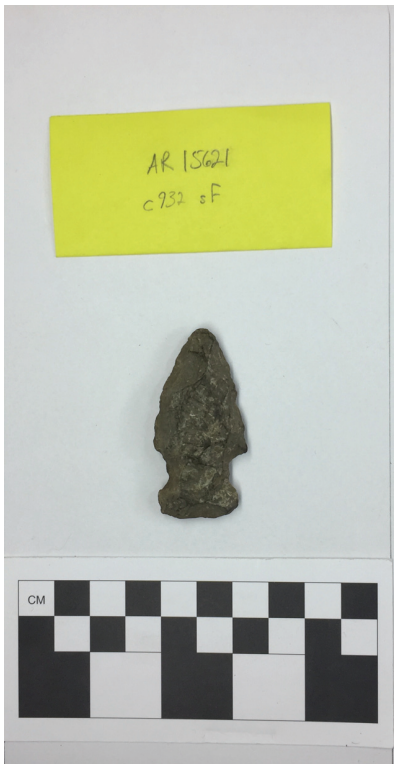
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AR 15636
c932 sF
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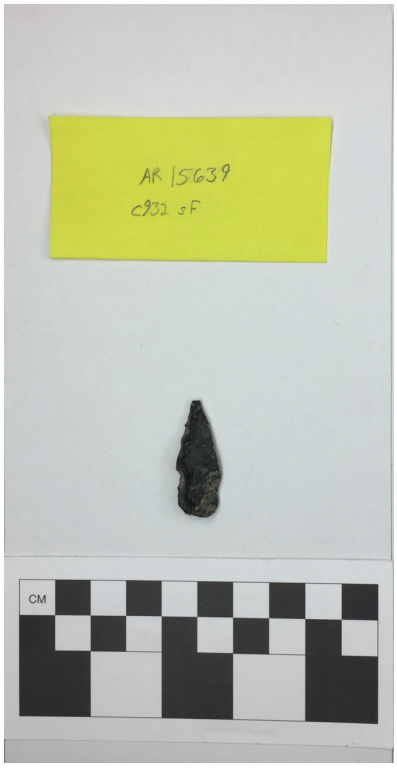
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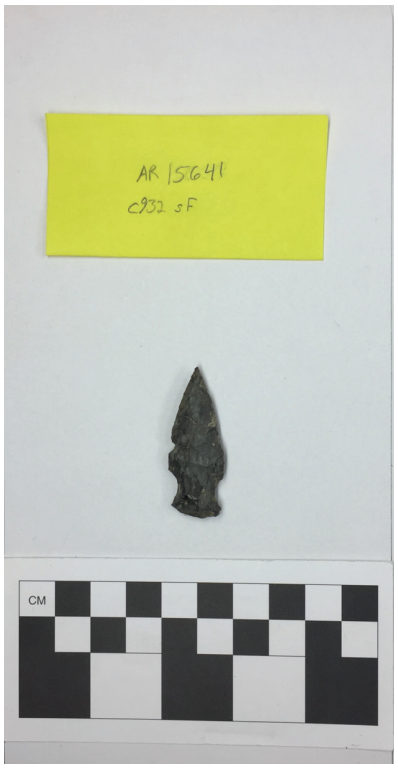
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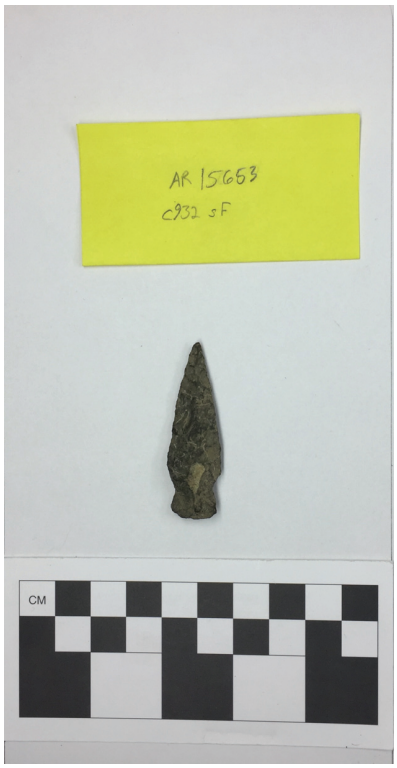
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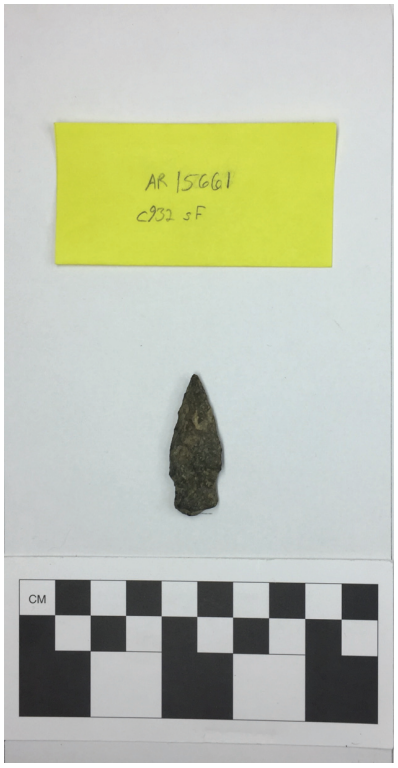
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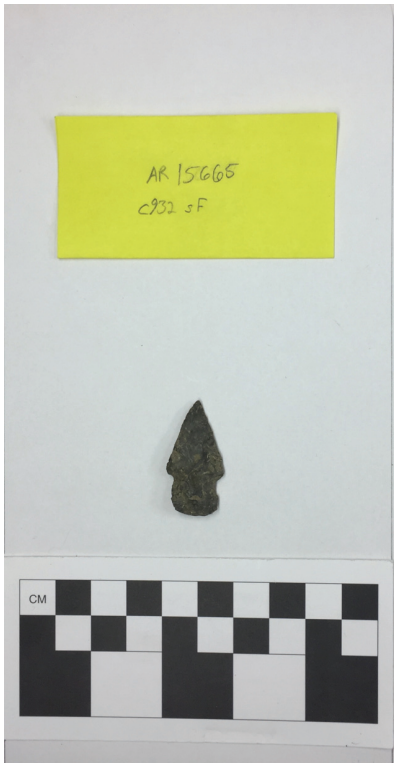
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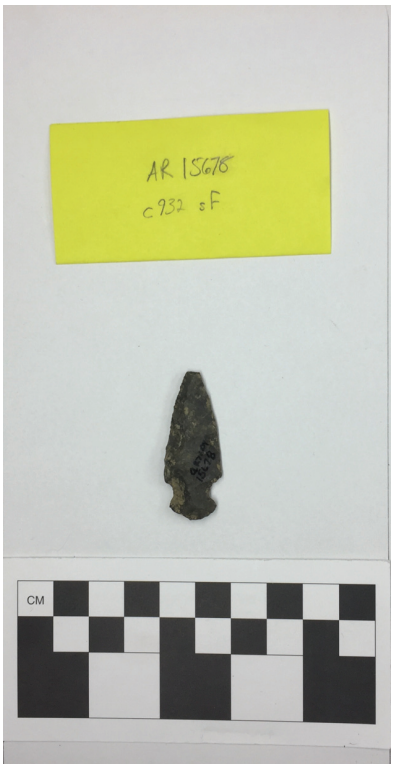
C932 sF
CM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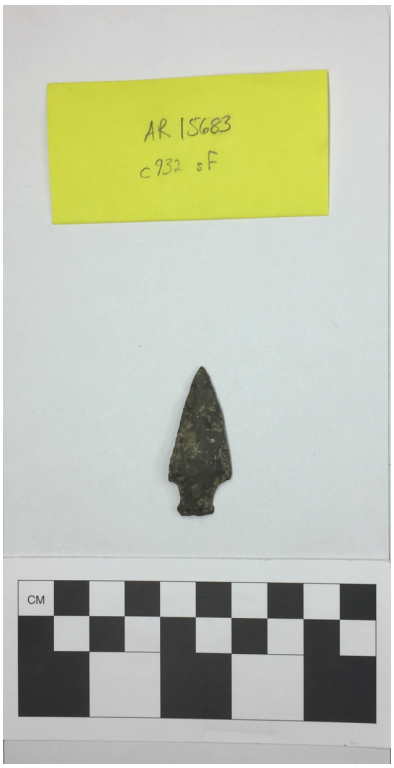
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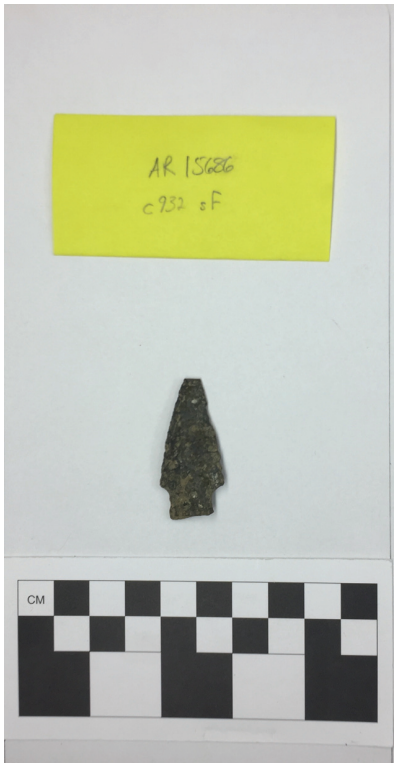
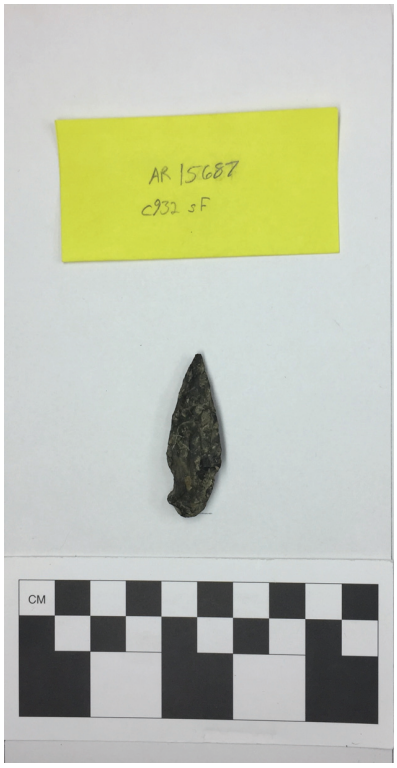
CM


AR 15686
c932 sF
CM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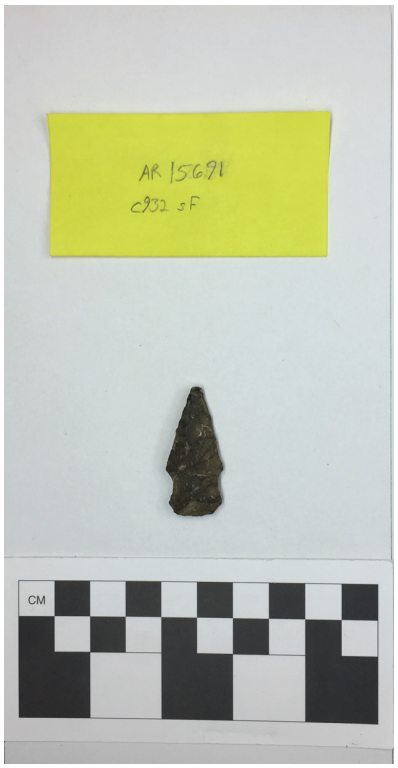
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AR 15698
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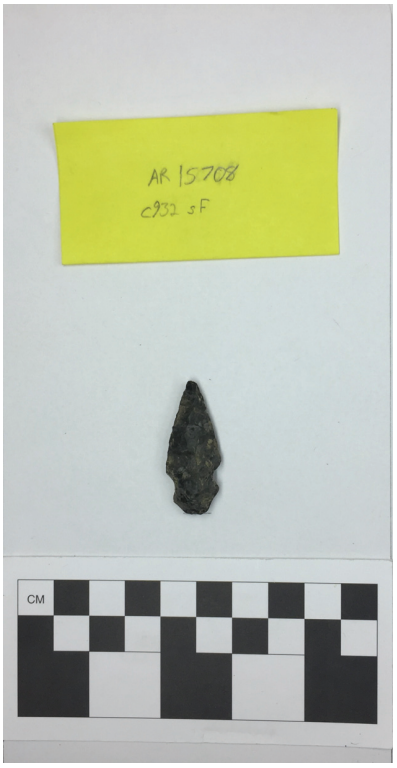
CM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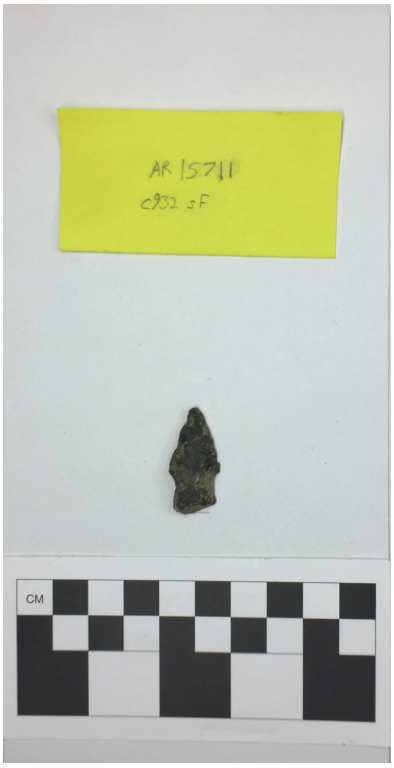
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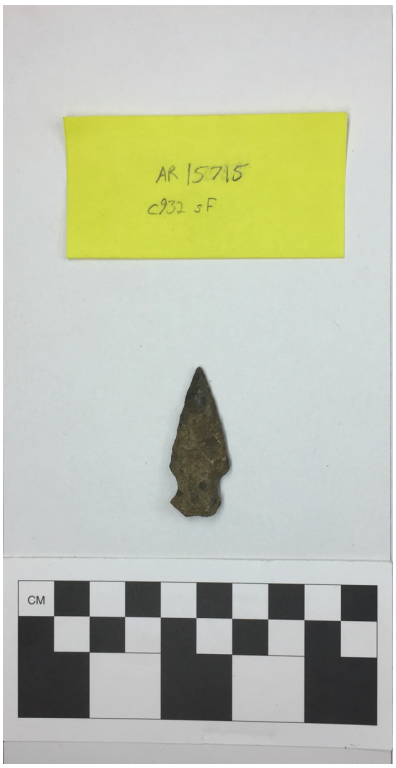
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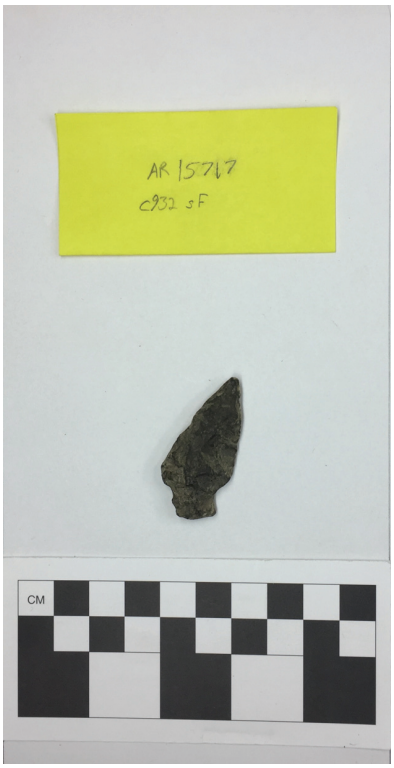
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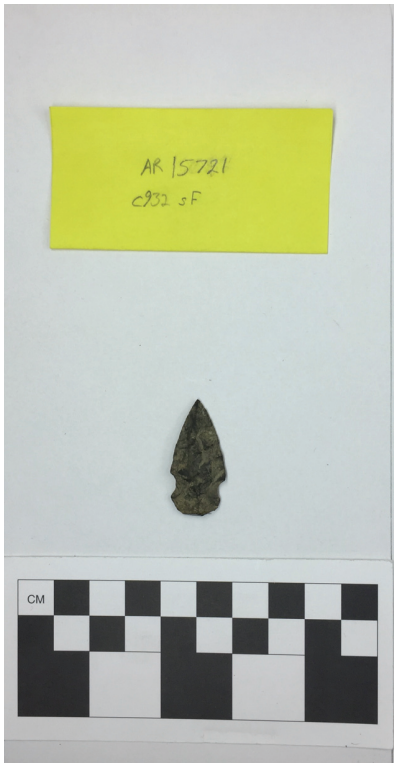
AR 15721
c932 sF
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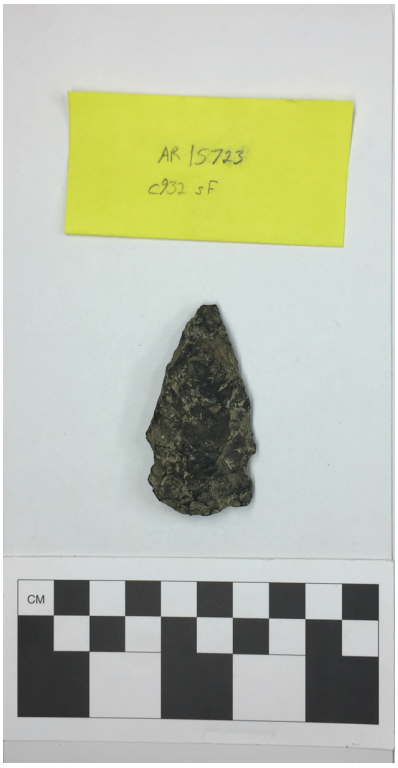
AR 15723
c932 sF
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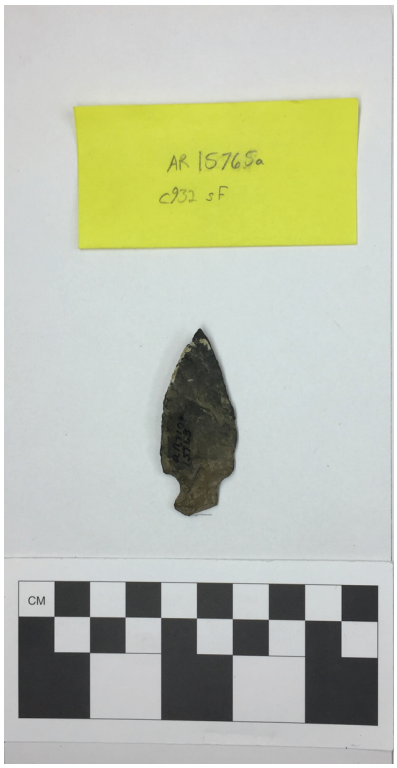
AR 15737
c932 sF
CM


AR 15765a
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CM


AR 15765b
c932 sF
CM


AR 15782
c932 sF
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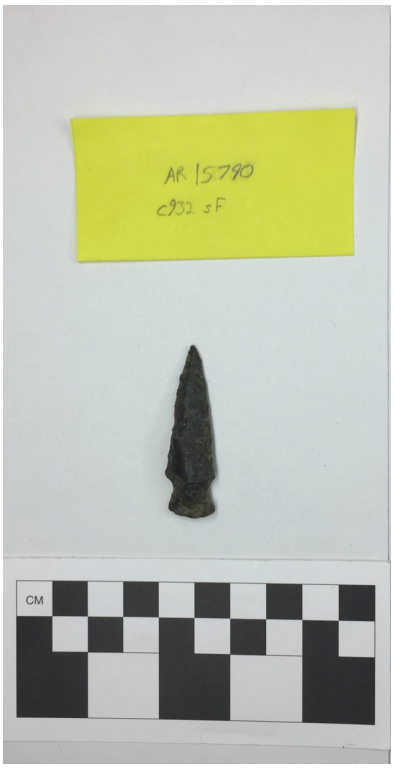
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c932 sF
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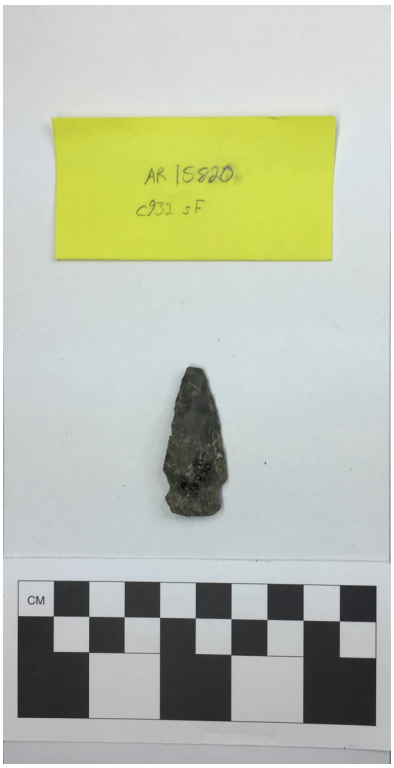
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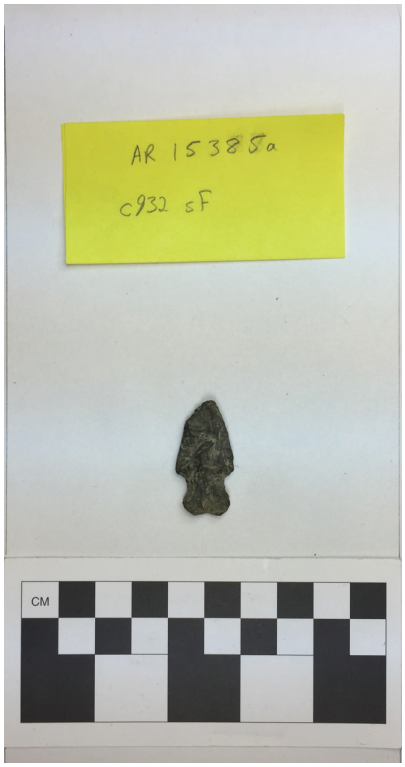
c932 sF
CM


AR 15385a
c932 sF
CM


AR 15385b
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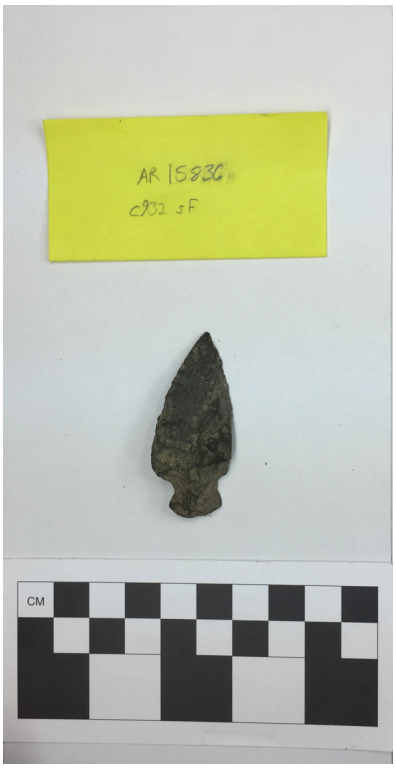
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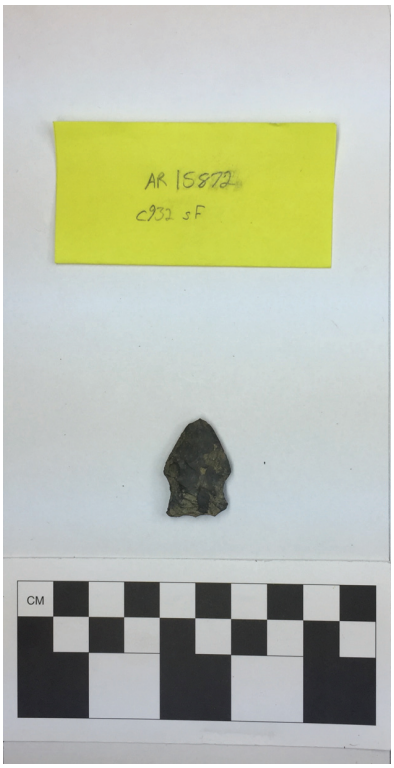
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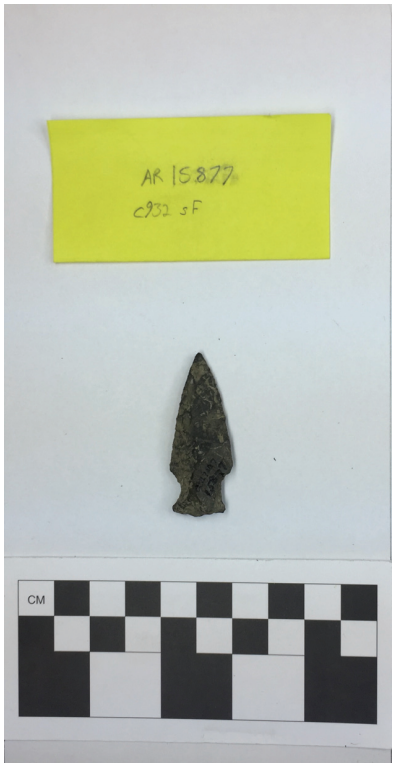
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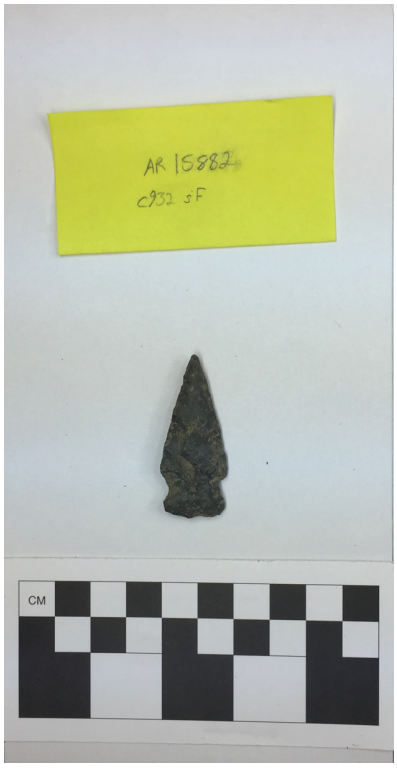
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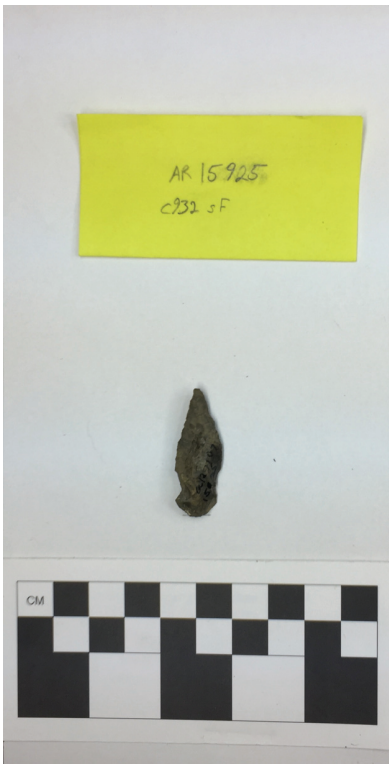
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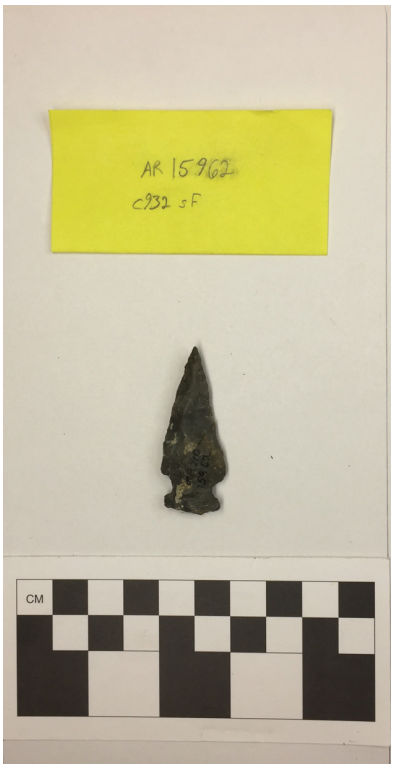
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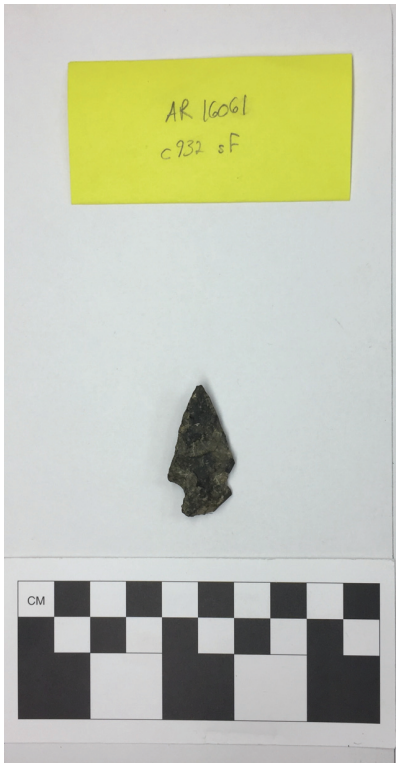
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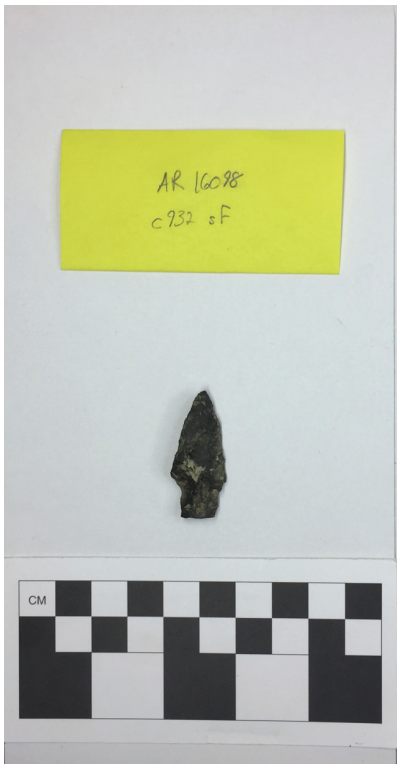
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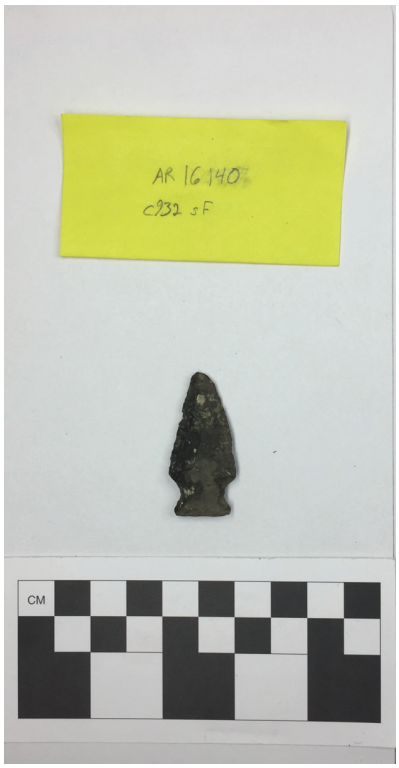
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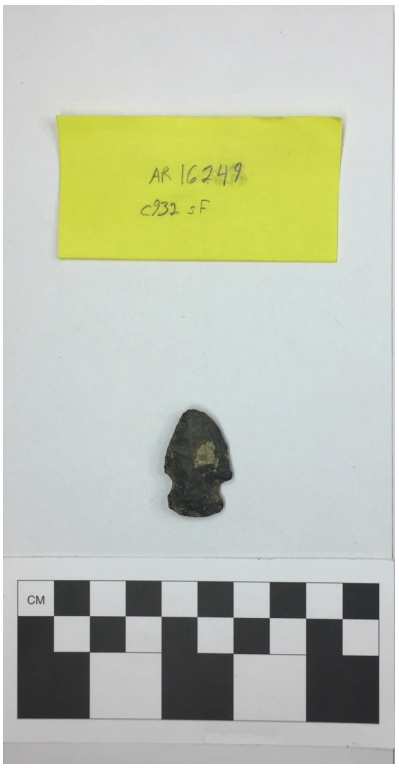
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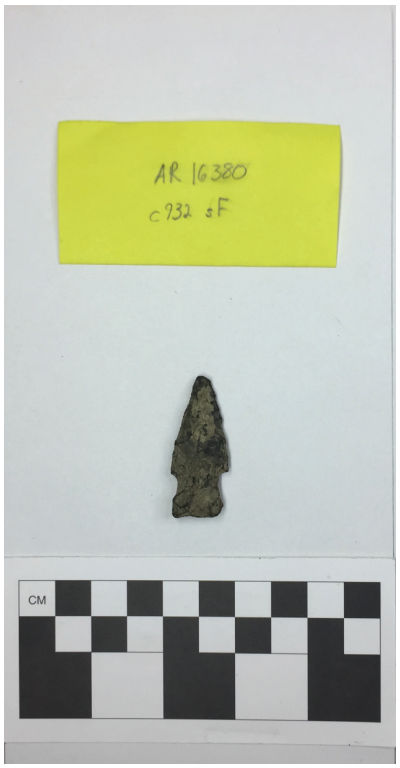
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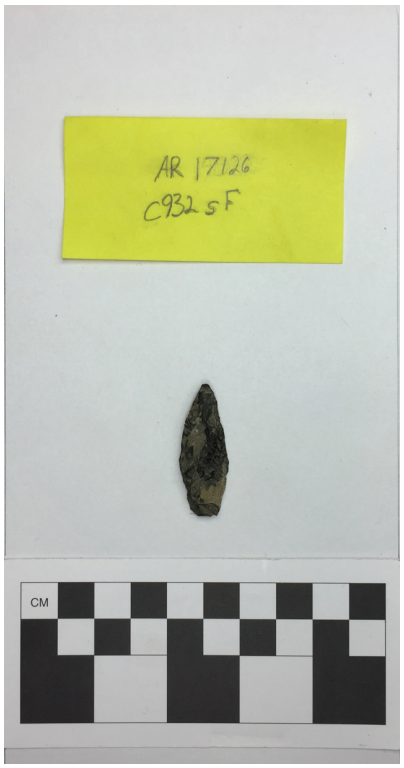
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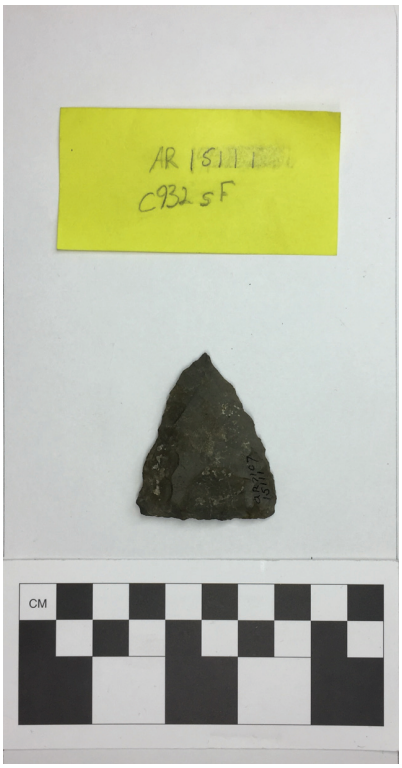
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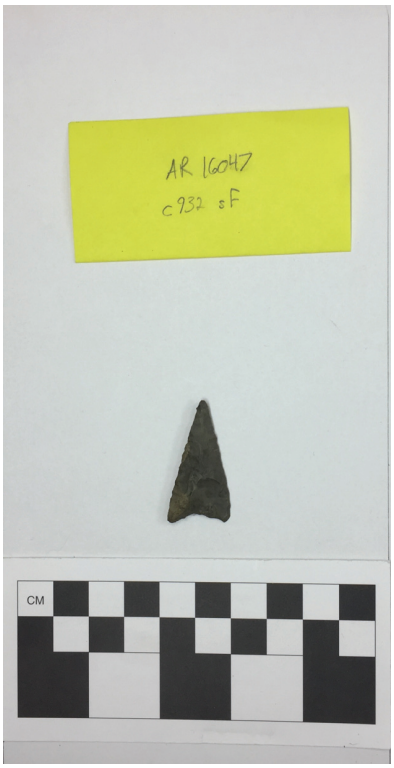
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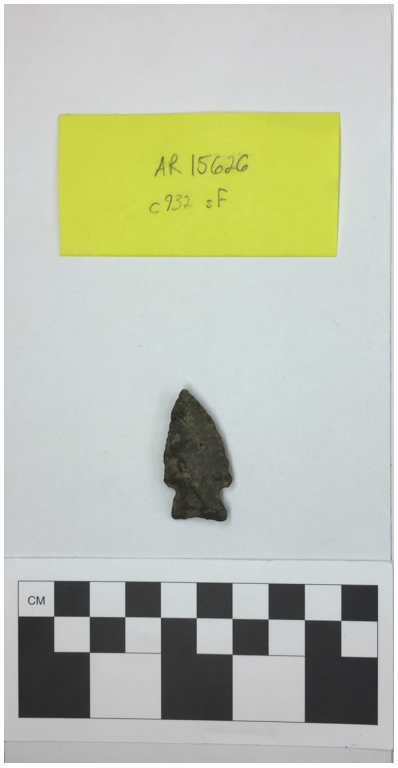
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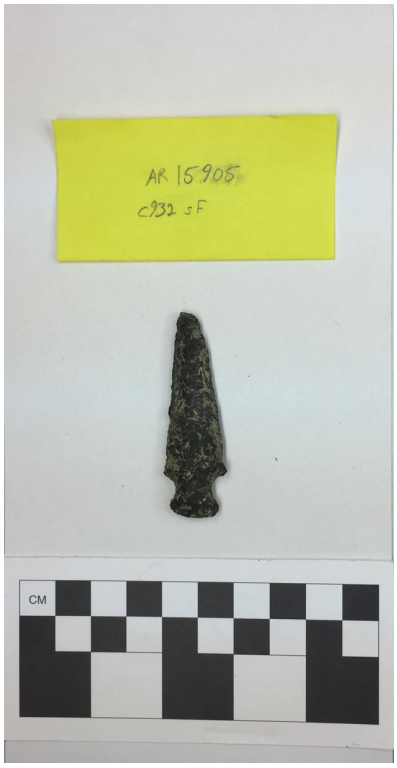
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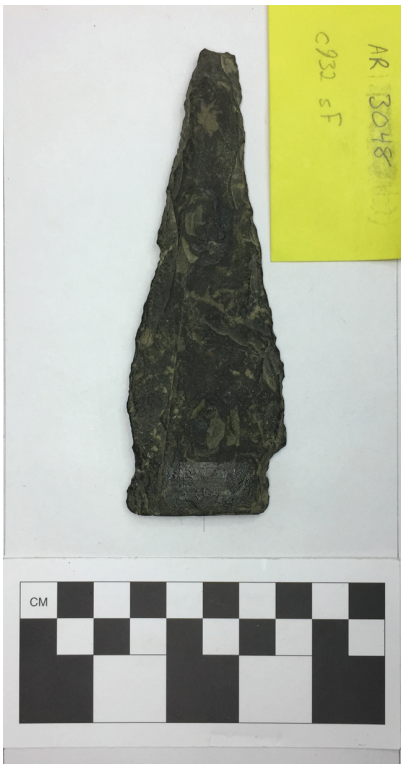
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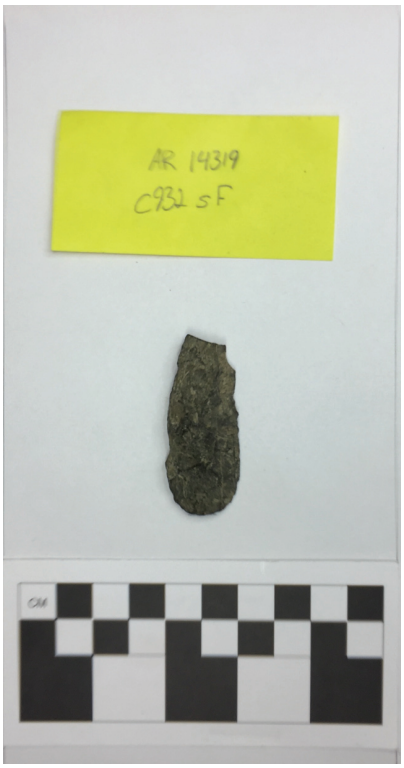
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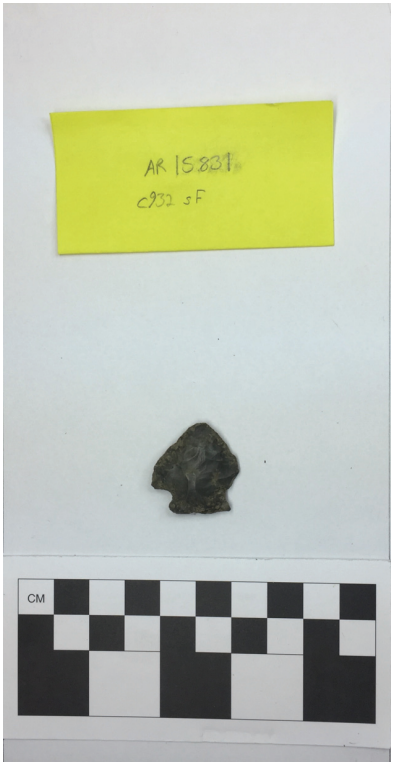
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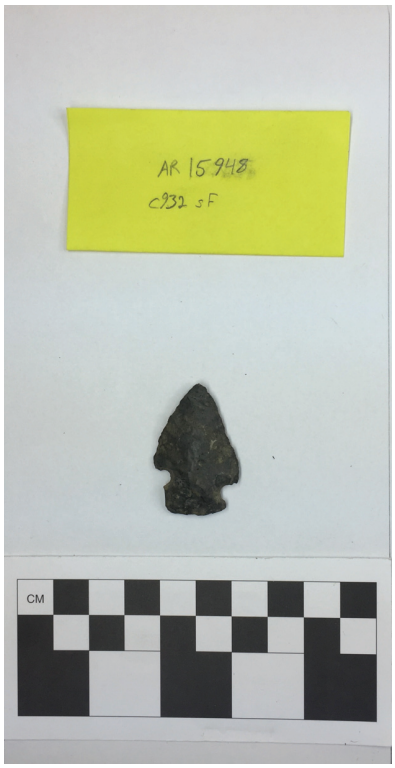
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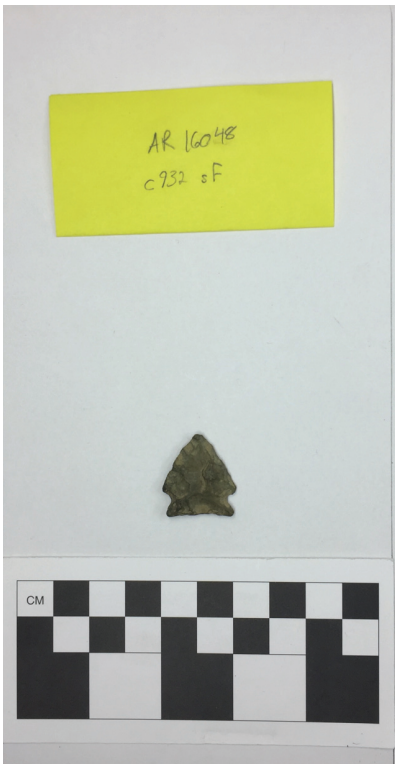
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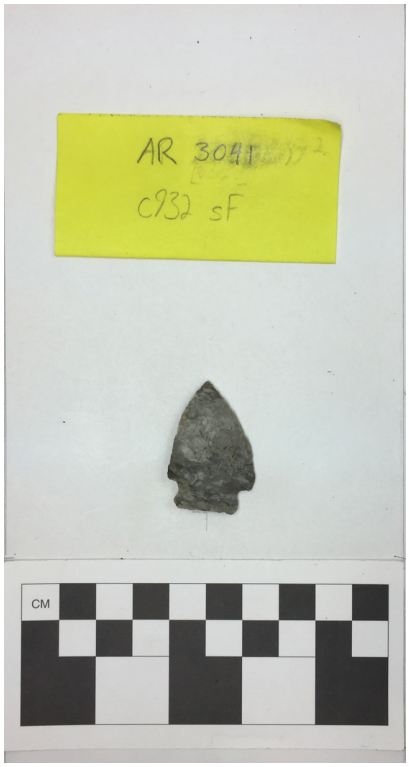
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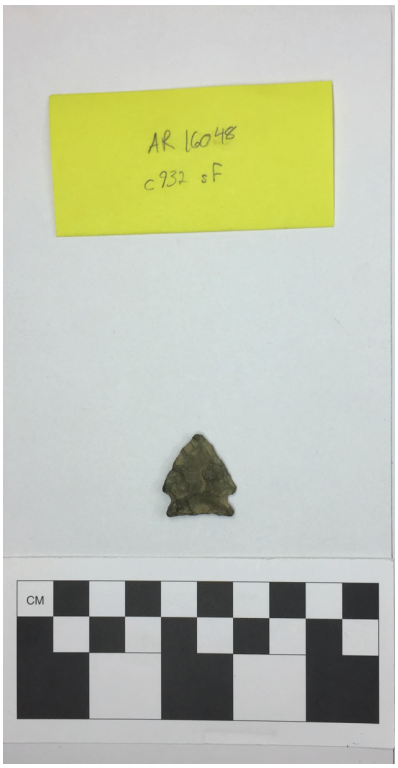
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