THE BENEFIT OF THE GIFT: EXCHANGE AND SOCIAL INTERACTION IN THE LATE ARCHAIC WESTERN GREAT LAKES

By

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Abstract

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Foraging societies with low population densities would seem an unlikely context in which to find extensive, continental scale, exchange systems featuring formal and standardized methods and materials of interaction. Yet, in the Late Archaic of the North American Midcontinent, this situation unfolds. How does formalized exchange function in such dispersed, small scale foraging societies? How does it help to create larger social entities and increasing sociopolitical complexity? How do such systems develop, what do they do, and why? In this study, a synthesis of anthropological theory on exchange and evolutionary theory of cooperative behavior is developed to produce a model of exchange with several testable predictions. These predictions include that differential access to exchange benefits will exist within and between communities, that exchange is inherently risky to participants and their communities, the frequency and scale of exchange will increase as trust is established and validated, exchange of material goods creates opportunities and incentives for social change, and conflict between communities is expected when trust is lost or undermined. These are then examined through a methodologically diverse set of studies involving analysis of lithic and copper artifacts to examine changes affecting Late Archaic societies in the western Great Lakes between 4000 and

2000 years ago. Data from the Late Archaic Riverside site, Middle Archaic Reigh site, and sites of the Late Archaic Burnt Rollways phase are examined to understand the production and movement of copper and lithic exchange materials, access to and benefits from exchange networks, and social changes accompanying the development of such systems of interaction. This study demonstrates that the Burnt Rollways phase is socially distinct from, and not interacting with, their downstream neighbors at Reigh and Riverside, while Riverside is engaged in a formal system of interaction and ritual with communities as distant as the lower Ohio River valley. As a consequence of this interaction network, Riverside exhibits differential access to benefits, standardization and ritualization of materials of interaction including formalized bifaces of Wyandotte chert and copper beads, intensification of exchange through time, significant social changes emphasizing the growing importance of women and children, and conflict.

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To my parents,
Dr. John D. Hill and Mary Ellen Hill,
whose support and encouragement made this all possible.

CHAPTER ONE

INTRODUCTION

In the summer of 1994, I stepped out of a Forest Service truck and began walking along a two-track dirt road. The warm sunlight flashed colors of white and gray off flakes of chert as I walked past a series of small marshy ponds and along a low sandy ridge. Small flecks of green peeked through the crisp bracken fern, at first looking like some kind of strange vegetation. Bending over for a closer look I discovered they were pieces of oxidized copper. This was strange, for I had learned that most of the prehistoric sites here contained little but stone tools and debris made from quartz. Fist-sized frost-white cobbles of quartz were found in the streambeds, in the soils, and along the lakeshores, chert was not. I had seen copper before—a small awl at one site, a small knife at another, and old collections carefully framed and placed behind glass—but never before had I seen so many pieces of copper, many of them unfinished and unidentifiable. The chert had come here on a long journey from far to the south; the copper here was just beginning a similar adventure. Their journeys would come to be mine as well, as I began to wonder about the people that carried them here and how these small pieces of stone and copper would come to be valued and exchanged in the economies of their societies over three thousand years ago.

My journey to this site began in early 1989 as I drove across the cold windswept prairies of North Dakota and into the sudden, claustrophobic closeness of the north woods. I had come to start a new job as the Forest Archaeologist of the Ottawa National Forest, and was eager to once again see the shores of the largest freshwater lake in the world—Lake Superior. The Ottawa hugs the southern shore of this vast sea, and I remember as a young child camping on its shores and watching waves crash during a summer gale. I was also eager for another reason; my own National Forest, the chance to build a program that did more than just find and hoard those jewels of our past, one that contributed value to the public and to the science of archaeology.

The Ottawa didn't disappoint. Within a few months I was involved with four of my neighbors, the Superior National Forest on the north shore of the lake, the Chippewa National Forest in the forests of central Minnesota, and the Chequamegon and Nicolet National Forests in northern Wisconsin. Snowbound in conference rooms, on sites from Minnesota to Michigan, and in the beautiful Chequamegon Hotel we would meet and plan a new program. Together with help from our Regional Office in Milwaukee, we began what is now known as Passport in Time. We took this program to Washington D.C., and eventually involved the entire USDA Forest Service. We had created a new approach to management of archaeological sites on National Forests, one in which volunteers would work with us as we began to learn more about the people that had lived on these now publicly owned lands for so many generations before us. We would contribute to society, to archaeology, and develop a new approach to managing our public heritage (Hill 1990).

With this vision, I began looking anew at the sites of the Ottawa. Which site would provide the most significant contributions to our understanding of the history and prehistory of the northwoods? Which sites would be accessible for volunteers? The list began to grow. At the top of the list were sites such as Timid Mink, a Woodland site from fifteen centuries ago that proved to be related to an as yet undefined Late Woodland phase. Many volunteers spent two summers slowly troweling the thin rocky soils, finding a piece of ancient pottery here, a long lost stone tool there, and a surprising green plastic toy frog. We eventually revealed the first prehistoric house known in the western Upper Peninsula (Hill 1995).

Other projects took us to Late Woodland sites such as River Vista. There we could literally see the outline where a prehistoric flintknapper sat making stone tools out of quartz hundreds of years earlier. This site was located on a trail made famous by the Ojibwa and French in the early seventeenth century, and when dates came back from our excavations we found that a part of the site dated to around 1600. We joked that if we put our ear to the ground we could hear *Frere Jacques* being sung as the missionaries and voyageurs made their way inland to the Ojibwa village at Lac Vieux Desert.

Our research took us to historic sites, too. For years we sorted through the pale olive green sands at the Norwich and Ohio Trap Rock mines. Michigan Technological University had just established a new graduate program in industrial archaeology, and we joined together to research the rich early history of copper mining in Michigan. For two years we set up camp on the north shore of Lake Gogebic, rising every morning as the mists faded over the lake and packing our equipment for another day. Driving to the site, we would pass the glowering black basalt cliffs of Norwich Bluff, then slowly wind our way up a narrow, rutted, and rocky dirt road through the dappled sunlight of thick maple forests to the summit. A mile walk down a dirt path hacked by machete out of the dense forest and worn smooth by our feet took us to the site of the Ohio Trap Rock Mine's stamp mill. Built around 1850 by a young Cornish millwright eager to bring new technology to these North American mines, this had perhaps been the most advanced stamp mill in the Keweenaw mining district in its time. But its time was short—the mill, mine, and town would be abandoned before the end of the decade. The remoteness of the mine, and ill fitting ideas of what a mine and community should consist led to its ultimate failure. Today it is no less remote. As our volunteers and students slowly peeled back the copper rich stamp sands that had washed in over the mill, we were amazed to see the beautifully crafted tongue-andgroove floors of two large buddles that had been used for separating copper from waste rock. Copper prevents the decay of organic materials such as wood, leather, and cloth, and the stamp sands had preserved an amazing time capsule from the 1850s. There on the wooden floor of the mill were barrels of copper, carefully filled and hastily abandoned long ago. Alongside them were scuffed leather boots and the remains of an intricate system to channel water into the buddles. Company records showed us that these miners came from Cornwall and Ireland, from Finland and the young United States, and that some of them moved on to mines in Australia while others stayed in North America. Some left for the gold fields of California. Their journeys had been long, and this was just one stop along the way. But they left a legacy in Michigan (Landon and Sutter 1994; Landon et al. 1994, 1996, 1999).

But the legacy of copper and the people who have sought and used it reaches much deeper into the past of Lake Superior. Other miners had long before hammered copper out of the bluffs of the Keweenaw highlands and searched for it along the streams and shores of the northwoods. Ohio Trap Rock and Norwich company records also revealed traces of these ancient miners. “Indian Diggings” were often sought by nineteenth century miners. These ancient pits were seen as proof that copper was present, and that a mine could extract it and reward its investors with dividends.

As we were sifting through the stamp sands of nineteenth century mines, we began to hear about a much older site. Not far away, on the banks of the East Branch of the Ontonagon River, collectors had used metal detectors to find copper knives, points, and nuggets. Stone tools were also visible in the sandy ruts of an unimproved road, and they showed us that these copper tools were much older, maybe dating back three or four thousand years to a period archaeologists call “Old Copper.” We visited this site in 1994, digging shovel tests in the fine sandy soils and examining the surface for artifacts. We worked our way over the eerily undulating surfaces of bogs and around several shallow, marshy ponds filled with cattails, the largest of which was known as Duck Lake. The site we found would take the name of this small lake.

We excavated through these fine sandy soils at Duck Lake for two summers (Hill 2006, Chapter Seven this volume). We learned that the soils formed from sand washed out from melting glaciers at the end of the Pleistocene. Digging several lines of deep auger probes into the soils showed that the river cut down through these sands thousands of years ago as the level of Lake Superior dropped hundreds of feet lower than it is today (Haywood 1998). We uncovered the cold ashes of long dead fires, around which people had talked and laughed, eaten and slept, and hammered copper into finely made beads, points, and knives. The charcoal from their fires told us they were here while the Egyptians reunited their lands under the New Kingdom, the Minoans dominated the Aegean, Hamurabi established the first known code of law in Mesopotamia, the Olmecs began to lay the foundation for Mesoamerican states, and the Shang Dynasty took the first steps on the long march of Chinese civilization. We discovered that the chert from which they made their tools came from distant places; most from the Mississippi Valley to the southwest, but some from Lake Ontario far to the east, others from the valley of the Knife River along the Upper Missouri far to the west. The copper they left behind was mostly unfinished; they took the finished tools and ornaments with them. As the chert tools had finished their journey here, the copper was just starting a new one. But to where? And how? And with whom?

In the summer of 1994, I stepped out of a Forest Service truck and began walking along a two-track dirt road. A new journey had just begun.

Organization of the Dissertation

This journey has been fueled by questions that first started to take form on that summer day in 1994. At first these questions were relatively simple; where did the chert come from and how did it get here? Where was the copper going? Did the people that came to Duck Lake live nearby, or were they members of more distant communities that traveled here to obtain and work copper?

Through time, the questions grew in complexity and scale. Today the questions focus on how interaction and exchange between communities combine distant societies into meaningful social groups, and how the use, production, and exchange of such items as copper and distant lithics contributes to the development of more complex social structures.

To answer these questions, several others must be addressed along the way. The following chapters provide introductions to the environmental and social contexts of this exchange, examine the acquisition, nature and social value of exchange resources, and address questions of who is interacting with whom and the nature of those interactions.

In Chapter Two, I develop a body of theory, founded in both cultural anthropology and evolutionary theory, that makes several predictions about how and when extra-community exchange and gift economies function to provide benefits to individuals and the communities of which they are members. This chapter views exchange and gifting as an evolutionary stable strategy in which the giving of gifts builds relationships of obligation that bring individual fitness benefits to the participants. Testable predictions from this body of theory include: a) individuals will employ the exchange of gifts to enhance their fitness when social networks are sufficiently connected to make such benefits available, b) some individuals will have access to exchange opportunities before others in their community, and c) those individuals will use exchange networks to promote their own interests and enhance their fitness. Their interest and fitness benefits may come in many forms, including increased access to resources, status from access to the exotic, and/or their potential to act as 'brokers' to the exotic in their community.

While this theory is broadly applicable, the present study will remain true to its origins and focus on the western Great Lakes region of North America during the later parts of the Archaic period (roughly 4000 to 2000 years ago). Chapter Three introduces the physical environment of a region defined by the shorelines of Lake Superior on the north and Lake Michigan on the east, by the Mississippi Valley on the west, and the northern reaches of prairie on the south (Figure 1.1). It is a land of hardwood forests and mixed forest-savannah in the south, and mixed coniferous and deciduous forests in the north. Several rivers originate in the northern part of the region, providing resources and natural transportation routes to past and present populations alike. A few of these flow north over rapids and waterfalls to Lake Superior, while most flow more gently southeast to Lake Michigan or southwest to the Mississippi River. The largest of these is the Wisconsin River, which crosses the region from north to south, ultimately turning west and joining the Mississippi River near the region's southern edge. Hundreds of lakes dot the north, while the southwest contains the deep, rugged valleys and high forested bluffs of an unglaciated plateau known as the Drifltess Region. This study area changed dramatically during the early Holocene as glaciers retreated and shorelines noticeably advanced and receded as lake levels rose and fell, finally stabilizing within the modern range of variation about the time this study begins.

The study begins during the waning days of the late Middle Archaic. Prior to 3600 years ago, the western Great Lakes was home to several groups of foragers who lived in small bands, hunted wild game, gathered wild plants, used copper tools such as tanged and socketed

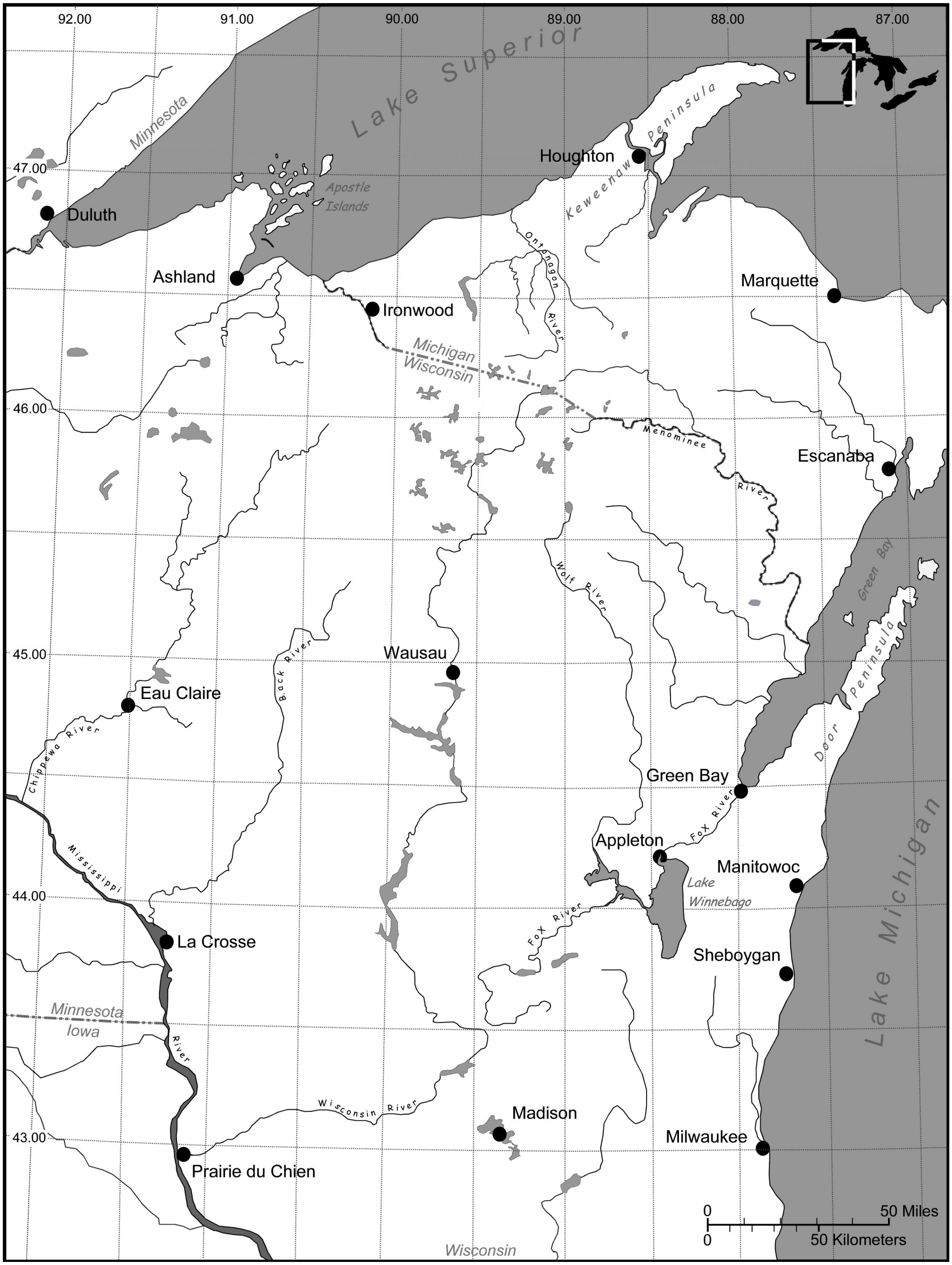


Figure 1.1: The western Great Lakes study area.

projectile points, and buried their dead in relatively simple community cemeteries. After 3600 years ago, copper artifacts become increasingly used for adornment rather than utility, cemeteries feature increasingly elaborate burial of some individuals, and exchange systems develop, through which exotic materials from the northern Great Plains, Rocky Mountains, eastern Great Lakes, central Mississippi Valley, and lower Ohio Valley all made their way to the western Great Lakes. After 3000 years ago, some of these exotic lithics come in the form of large formal bifaces made from Wyandotte chert and Burlington chert. Taken together, this suite of changes tells a story of major transformation affecting the region's societies. Chapter Four introduces us to these peoples and their societies, known to archaeologists today as the Reigh, Burnt Rollways, Preston, and Durst phases; and as the Old Copper complex—for their use of copper tools—and Red Ocher complex—for their practice of burying their dead with life-affirming powdered red hematite. This chapter also examines the distribution of populations during this time and shows that these people were largely concentrated from Lake Winnebago to the western shore of Green Bay, in the Black River area as it flows southwest to the Mississippi Valley, and in the Northern Highlands with its hundreds of inland lakes.

Several sites are used in this research to represent these populations and phases. These are discussed briefly in Chapter Four, and are further detailed in Appendix I. The earliest is the Reigh site, where Middle Archaic "Old Copper" people buried their dead between 4500 and 3700 years ago near Lake Winnebago (Baerreis et al. 1954). The presence of few items buried with the dead, and the relatively equal treatment people received in death, hints at a society that was fairly egalitarian and where trade and interaction with other contemporary societies was limited. Reigh shows us what social conditions were like around 4000 years ago, conditions that had changed dramatically by 3000 years ago as evidenced by the Riverside site. By 3000 years ago, the center of mortuary activities in the region had shifted north, away from the Reigh site and to the mouth of the Menominee River on Green Bay. Today this site is known as Riverside and over sixty men, women, and children were buried there between 3000 and 2000 years ago (Hruska 1967; Papworth 1967; Pfeiffer 1977; Pleger 1998, 2000). Their survivors had buried a few with dozens of stone blades made hundreds of miles to the south in the Ohio Valley, hundreds of copper beads, and especially poignantly with powdered red hematite which historic native communities used as a symbol for life. Today these practices tell us that their society was very different from the earlier communities represented at Reigh. Some had access to distant exotic resources and people, and somehow this brought them special consideration within their community.

Other communities were found upstream from Reigh and Riverside on the shores of the many lakes that make up the Northern Highlands area. No cemeteries are known here from this time; did these people take their dead to Reigh, and later to Riverside? Were these some of the communities that made up Old Copper and Red Ocher society, or do they represent other peoples? Did they interact through trade or ceremony with their downstream neighbors? Later in this study, lithic source analysis and copper trace element analysis will be used to show that they were separate communities from those at Reigh and later at Riverside. Archaeologists today know these people as the Burnt Rollways Phase, named after the site where they were first identified. Their sites were seasonal homes—places from which they hunted, fished, and gathered foods in season before moving to another location for other resources. Each small band of people would move several times a year, utilizing the same sites over and over, and leaving a record of their activities in the form of lost and broken tools, food remains, hearths, animal bone, and other features including the remains of houses and pits for processing nuts. These people are represented in this study by sites such as Burnt Rollways (Salzer 1969), Rainbow Dam East, and Rainbow Dam West (Moffat and Speth 1999). Around 3400 years ago, one of these bands traveled north to the Keweenaw Highlands of Michigan to collect copper along the banks of the East Branch of the Ontonagon River. This band is represented by the Duck Lake site where this chapter began.

So the egalitarian societies of Reigh gave way to more complex social arrangements and communities in which distant and exotic items reflect different social positions for a few people (Pleger 2000). Other upstream communities are gathering and working copper, which is often used to display these special social positions in the Riverside community. Some people have ties to other communities, through which these exotic items are exchanged or given as gifts to build trust and strengthen relationships. Today, archaeologists find obsidian from the Northern Rockies, flint from the upper Missouri Valley, Lake Ontario, the middle Mississippi Valley, and Ohio Valley, and shell from the Gulf Coast, side by side by side in the sites and graves left by these people of the upper Great Lakes. Copper beads and tools from Lake Superior are found from the northern Plains to the Ohio Valley and beyond. Connections between communities had not just grown, they had exploded. Yet, as I originally started to wonder on that summer day in 1994, what were these connections? In Chapter Five we will explore the nature of these increasingly interconnected communities. Is the movement of exotic items around the continent simply the result of multiple small interactions between neighbors, or is something more complex taking place? Perhaps this is the development of a growing sense of larger social context. For the first time, upper Great Lakes communities are communicating with distant communities in the Ohio Valley, Mississippi Valley, and beyond through these interactions. Are ideas, symbols, and beliefs traveling with these goods as well? In this chapter we will see that this explosion of interaction results from the development and participation in a system of ideas and practices that is shared through much of the midcontinent. Evidence for this comes in many forms, including the specialized production of large blades in the Ohio Valley so that they may be recognized as authentic symbols of the ideas they represent (Hill 2007, Chapters Five and Six this volume), and in increasing conflict between communities. Today we can see the result of this conflict in sites such as Convent Knoll (Overstreet 1980), where several young males were killed, mutilated, and unceremoniously buried. Looking at this site we get a clear impression of a single raid, perhaps one community on another. The raiders appear to have killed one man and a young child, who were later carefully buried with finely crafted exotic stone blades. Several of the raiders were also killed—perhaps defeated by the defending community—and they were mutilated and haphazardly dumped in a common grave. Other signs of interpersonal violence are found at Riverside, where several individuals sustained severe injuries, and young males are underrepresented—perhaps as a result of raids on other communities from which they never returned. Interaction with others often comes at a price, but it may also bring benefits. Some individuals gained position in their communities by having access to distant goods and ideas, and their communities likely benefited from having such "brokers to the other."

Yet what is happening within these communities as some gain access to exotic materials and ideas? And what do these exotic items mean within these societies? These questions are examined in Chapter Six, where we will look at who is buried with what. At Reigh, very few individuals were accompanied with grave goods. At Riverside, several individuals were buried with exotic Ohio Valley blades, hundreds of copper beads, and other goods. These items are often associated with women and children—unlike Reigh where males were more prominently featured. Are women and children gaining status? Does this represent the formation of corporate groups such as lineages in which social rights and responsibilities are passed from one generation to the next? Are wives and children somehow associated with the number or quality of connections men have with other distant communities? And how do the symbols of exotic blades and copper represent these changes?

Today we can trace these material goods and symbols from their origins through their social use and ultimate disposal or burial, and by doing so gain a better picture of which communities are interacting with one another, and how. Around 3400 years ago, a Burnt Rollways phase community traveled north to the Keweenaw Highlands and camped on the banks of the East Branch of the Ontonagon River. Here at the Duck Lake site we get a clear picture of how, and by whom, copper was collected and worked into tools and ornaments—perhaps the same ones that later made their way downstream to Red Ocher communities and beyond, or perhaps not. They carried along stone tools made from cherts found in southwestern Wisconsin but knew how to and did make tools from the local quartz. The copper they used was not mined as later copper was; they collected it from the streambeds and moraines where glaciers had deposited it after scouring out the highlands during the Pleistocene. Copper manufacture was not complex; fire, water, a small anvil stone and a hammerstone were often the only tools necessary to make knives, projectile points, and beads. Surprisingly, this is one of the few sites that clearly shows us today how these people obtained and worked copper during this time. Chapter Seven will provide a detailed discussion of this site, and help us understand the nature of procurement and production of a resource that was valued and exchanged over a large part of the continent.

The stone tools at Duck Lake are largely made from cherts found in southwestern Wisconsin. Were people traveling from that far south to gather copper? It seems likely that they were not—that this chert was available closer to home or through less formal trade with neighbors. By carefully looking at the raw materials used for stone tools—examining their color, texture, translucence, and even fossils within them—it is possible to identify the geologic formations from which they were gathered. By looking at details of their production, we can gain a clearer picture of what they were made and used for, what people were planning for while producing them, and how they traveled this far north. The first half of Chapter Eight will lead us through this process for Duck Lake, Burnt Rollways, Reigh, and Riverside, and examine how and where each of these communities gathered their raw materials as well as with whom they may have interacted to get materials they lacked or wanted. Was each of these communities getting their resources from the same locations or people? Were they trading with one another, and if so what did this trade mean? Were these, perhaps, even the same communities at different times of the year—summer inland, spring on the shore for fishing and public ceremony? One way of examining these questions is through analysis of the stone they used for tools, which shows that they were using similar resources but in different ways. They were not the same communities but separate populations. But were they interacting through exchange?

For that question we turn to copper artifacts. Is the copper gathered and carefully worked at Duck Lake the same copper buried as beads with women and children at Riverside? Is this the same copper that individuals gave as gifts or exchanged for favors throughout the midcontinent? Chemical trace element analysis can actually answer these questions. When the copper formed millions of years ago it contained small amounts of impurities—arsenic and gold, silver and tungsten, and many others—that vary from sample to sample depending on the chemical elements present in each geologic setting. So copper has within it traces of other elements, and the presence and quantity of these elements differs from one location to another. By using a laser to vaporize a very small sample of copper, then “sniffing” that sample with a mass spectrometer, we can identify these elements and measure the quantity of each within the copper. The results show that each of the Burnt Rollways phase communities gathered their copper from slightly different locations—probably locally from the streams and moraines around their sites. Did this copper make it to Riverside? To Reigh? By comparing each of these sites in the second half of Chapter Eight, we will see Riverside and Reigh communities use one set of copper sources, while the Burnt Rollways communities obtain their copper elsewhere. It seems that these neighboring populations were not interacting through the exchange of copper goods. It appears likely that they are two separate societies sharing a similar adaptation and environment, yet avoiding meaningful interaction.

My journey began over 14 years ago when I stepped out of a truck and began asking these questions. Like the copper and stone blades of long ago, I have also traveled across the continent in search of the answers: to Washington State University to conduct this research; to collections of the tools and even remains of these people in Milwaukee, Madison, LaCrosse, and Beloit, Wisconsin; to records in Lansing, Michigan; to the cold and rocky shores of Lake Superior and the sandy shores of Lake Michigan, and the knee-deep mud and rocky bluffs of the Mississippi valley to collect chert samples; and to laboratories in Long Beach, California to vaporize copper with lasers and analyze the contents with a mass spectrometer. Each of these locations has helped answer a question, and in Chapter Nine we will look at these answers. What happened in these communities so long ago? How were gifts and trade used to build larger social contexts in the midcontinent, and how did individuals benefit from these activities? Who was interacting with whom, and what did those interactions mean? Fourteen years later we have some of the answers, yet many more questions remain. This will all be presented at the end of this volume—what do we know now, and what more do we have to learn?

CHAPTER TWO

THE BENEFIT OF THE GIFT: AN EVOLUTIONARY PERSPECTIVE ON THE DEVELOPMENT OF INTERCOMMUNITY INTERACTION AND EXCHANGE NETWORKS

Social scientists have long considered exchange to be a central form of social interaction and a catalyst for forming bonds between individuals and societies. Many social theorists and researchers have examined exchange, including the perceptive and influential works of such notable figures as Emile Durkheim (1964), Marcel Mauss (1990) Bronislaw Malinowski (1961), F. E. Williams (1969), Claude Levi-Strauss (1969), and Marshall Sahlins (1972) among many others. These studies have laid the foundation for a richly detailed and theoretically diverse examination of this fundamental aspect of human society.

Other fields of study—biology, psychology, and anthropology—have since developed and examined new ways of understanding behavior based in evolutionary theory. This chapter will first review previous anthropological efforts to study exchange, which is then followed by a review of some of the major approaches toward understanding the biological basis of cooperative behaviors. Owing to the vast body of research in both fields, these overviews are not intended as comprehensive but rather illustrative of broad findings and basic theoretical foundations.

Following this overview, a synthesis of the two fields will be proposed which provides heuristic and methodological benefits to the archaeological and anthropological study of exchange, interaction, and social networks. I contend that such a synthesis is both possible and productive, and yields a model for the development and functioning of human exchange systems that will inform the remainder of the study.

‘Exchange’ can refer to many different categories of interaction ranging from food sharing in forager communities to the functioning of complex market economies and the production, distribution, and consumption of commodities. Throughout this study, exchange refers to the social interactions that attend the exchange of goods and gifts between communities.

Exchange and Social Integration

Exchange is simply the act of, and obligations that flow from, giving and receiving. Yet its power rests in forging relationships, maintaining social bonds, creating obligations and debt, gaining status and social position, and obtaining resources needed for the life and reproduction of individuals and societies. As early as 1893, Emil Durkheim (1964) noted the central role of exchange in creating *organic solidarity* in complex societies. Organic solidarity arose through the division of labor and the necessary exchange of goods and cooperation between unlike individuals pursuing individual interests, and was viewed in opposition to mechanical solidarity which arose from individuals who shared similar backgrounds and who were in frequent interaction. Viewed from this perspective, exchange is cast as an interaction of inherent conflict and inequality.

Durkheim’s nephew and student, Marcel Mauss, followed a different path. By focusing on the power of the gift itself, Mauss (1990) identified three obligations inherent in any relationship mediated through exchange; 1) the obligation to give, 2) the obligation to receive, and 3) the obligation to reciprocate. In other words gifts *must* be given, gifts *must* be accepted, and the acceptance of the gift conveys to the recipient an *obligation* to reciprocate. Mauss sees an innate power in the gift itself, and pursued this power through the Maori concept of *hau* in which the gift has a spirit that must be propitiated and served through reciprocity.

Levi-Strauss (1969) looked instead to the innate and unconscious structure of the human mind to understand the power of the gift and its ability to forge social bonds (deWaal Malefijt 1979:325-332). To Levi-Strauss (1969:52-68), the exchange of food, manufactured objects, and women creates relationships, and women given in marriage serve as the *supreme gift* that unites disparate and unrelated groups. In an insightful thought experiment, he proposed a restaurant scene in which two strangers silently share a table until one offers wine to the other. The offer of wine creates a relationship where before there was merely spatial juxtaposition. Once offered, the gift has created a relationship that cannot be undone:

> Wine offered calls for wine returned, cordiality requires cordiality. The relationship of indifference can never be restored once it has been ended… From now on, the relationship can only be cordial or hostile. There is no way of refusing the neighbors offer of his glass of wine without being insulting. Further, the acceptance of this offer sanctions another offer, for conversation. In this way a whole range of trivial social ties are established by a series of alternating oscillations, in which offering gives one a right, and receiving makes one obligated, and always beyond what has been given or accepted. [Levi-Strauss 1969:59]

Levi-Strauss' view of the exchange of women as the supreme gift echoes the earlier ideas of F. E. Williams. Working in Papua New Guinea in the 1920s and1930s, Williams (1969:166-169) proposed that exchange was linked to the development of rules requiring marriage outside a defined social group, or exogamy. Exchange was seen as a way of creating relationships between individuals and groups to forestall hostilities. Gifts created fellowship between groups, and the strongest bonds were formed through the exchange of females in marriage. Females, then, were viewed as reserved for exchange, and rules were created forbidding marriage of females within the home community.

Sahlins (1972) later built upon the large body of exchange research by defining different categories of reciprocity—generalized, balanced, and negative—that correlate with social distance (Figure 2.1). Generalized reciprocity, with its lack of specified value or time of reciprocation, predominates within the small scales of households and lineages. At greater social distances, balanced reciprocity comes to dominate, with its specified values and times of reciprocation. With its expectation and stipulation of return, balanced reciprocity characterizes exchange interactions within a village, tribe, or between different social groups. At intertribal and intersocietal scales, reciprocity may take a more competitive form where individuals in one group attempt to gain an advantage over the other group (and advantage within their own group) through the process of exchange.

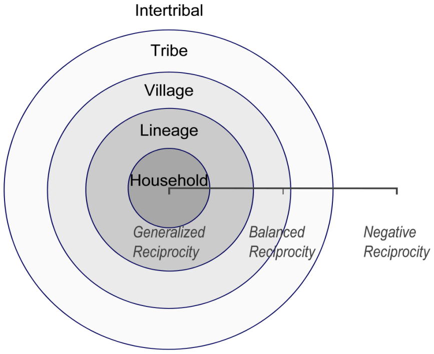


Figure 2.1. Sahlins' reciprocity sectors or spheres of interaction (after Sahlins 1972:Figure 5.1)

In an insightful essay, Gregory (1982) elucidates the motivations of gift transactors. In Gregory's observation, those involved in gift economies are not seeking profit maximization. To the contrary, "the aim of a gift transactor is to acquire a large following of people (gift-debtors) who are obligated to him" (Gregory 1982:51). Gregory thus uses Mauss' power of the gift to create not only bonds between individuals, but bonds of obligation which convey advantage to the giver. Chris Gosden (1989) builds on this idea further to formulate a new economic model—one built upon the accumulation of the obligation of others and the transaction of debt.

Each of these contributions has expanded our views of exchange in human societies, yet they suggest that a deeper process is in place—one in which exchange is somehow a part of human nature. Anthropology and the social sciences have explained how exchange works in specific contexts, but an understanding of the fundamental nature of such social interaction could be valuable for its ability to construct models of human interaction.

Evolutionary Approaches to Cooperation and Interaction

While social theorists and anthropologists were debating the processes and motivations of cooperation, competition, and exchange, biology was struggling with the very origins and basis of cooperation. Why do organisms cooperate? Since cooperation, by definition, involves giving up resources or effort for others, how could it evolve, and why does it take the forms it does? Exchange is, of course, a type of cooperation in which individuals pursue their interests by cooperating with others through social networks. The biological basis of these behaviors was difficult to conceive, yet, I argue, is critical to a fundamental understanding of exchange.

Hamilton (1964) first approached this issue by noting that individuals may gain a net reproductive advantage by helping those to whom they are most closely related. This inclusive fitness is governed by the rule of $c < br$, in which an individual is most likely to help another when the cost (c) is less than the benefit (b) provided to the recipient, discounted by the degree to which the beneficiary is related to the actor (r). Cooperation with related individuals is a behavior that provides a selective advantage by increasing the frequency of the alleles that produce the behavior. Cooperation between closely related individuals can be explained through this model, and the core elements of sociality can be created in the form of families, households, and lineages by observing that individuals will be most likely to help and cooperate with others most closely related to themselves.

However, inclusive fitness does not explain cooperation and interaction between non-related individuals. One explanation for this lies in Trivers' (1971) theory of reciprocal altruism. While similar to the equation for inclusive fitness, reciprocal altruism predicts that cooperation and interaction between non-related individuals will occur when the cost to the actor (c) is less than the benefit to the recipient (b) discounted by "w" which is a measure of the degree to which a return benefit is expected. In other words, cooperation with non-related individuals provides a selective advantage when that behavior ultimately produces a benefit for the actor. Reciprocal altruism is in some ways an explanation of how we form societies, alliances, and coalitions through the variable "w," or the expectation of future benefit.

But when to cooperate and when to serve our individual self interest? Axelrod and Hamilton (1981) show this to be a false dichotomy. We serve our individual self interest *through* cooperation with others. Modeling cooperative behavior using game theory, Axelrod and Hamilton (1981) found that selfish interaction strategies—those that attempt to gain the greatest return while imposing the costs on others—produced the greatest return in short duration interactions. However, in cases where interaction is likely to be prolonged, as in life, the greatest long-term individual benefit was gained through cooperation with others. Several strategies have been found to produce benefits through cooperation, including those of indirect reciprocity and image scoring (Nowak and Sigmund 1998, 2005), group selection methods such as multilevel selection (Traulsen and Nowak 2006), and *tit-for-tat* (Axelrod and Hamilton 1981). Tit-for-tat is the simplest and most basic of these strategies, and is used in this model due to its basic characteristics. It is built upon simple rules of cooperation and reciprocation, and is an evolutionarily stable strategy that, once established, is not outperformed by more selfish approaches.

Synthesis: Trivers and Levi-Strauss Share a Bottle of Wine

The anthropological study of exchange and the biological study of evolved cooperative behaviors can be woven together to form a model of exchange in which interaction between individuals through exchange and the development of social networks are viewed as an adaptive trait that, under certain circumstances, increase the fitness of participating individuals. Similar models have been developed for cooperation and exchange *within* communities (e.g., Winterhalder 1997); here I attempt to develop one for exchange *between* communities.

Levi-Strauss (1987) criticized Mauss for resorting to the mystical concept of *hau* to explain the power of the gift. Instead, Levi-Strauss proposed:

> *Hau* is not the ultimate explanation for exchange; it is the conscious form whereby men of a given society, in which the problem had particular importance, apprehended an unconscious necessity whose explanation lies elsewhere…Once the indigenous conception has been isolated, it must be reduced by an objective critique so as to reach the underlying reality. We have very little chance of finding that reality in conscious formulations; a better chance in *unconscious mental structures*… [1987:48-49, italics added]

Levi-Strauss was correct, but not necessarily in the interpretations he proposes. His unconscious mental structures are perhaps best seen as the evolved psychological mechanisms of inclusive fitness and, especially, reciprocal altruism. Evolutionary psychology and biology demonstrate that humans have innate traits, selected for during our evolution, that promote the use of genetic relatedness, potential return, and tit-for-tat strategies in decision-making processes for interaction with others. Mauss' spirit of the gift is indeed powerful; the obligations to give, receive, and reciprocate are the manifestations of our innate tit-for-tat strategy (for an interesting application of this view, see Görlich 1998).

The obvious similarities between Hamilton's (1964) Inclusive Fitness theory and Sahlins' (1972:199) kinship and residential sectors have long been recognized—most notably by Sahlins himself in a critique of evolutionary approaches to human behavior (Sahlins 1976). The relationship between social distance and reciprocity (and Durkheim's mechanical and organic solidarity) is the cultural correlate of the relationship between kin selection and reciprocal altruism (Figure 2.2). Kin selection and generalized reciprocity are two sides of the same phenomenon, with their strongest effects occurring within small social distances where the degree of relatedness is high. At this scale, an individual's fitness depends on the fitness of other individuals in the society by degrees of relatedness. In simple terms, kinship dominates cooperative activities and social interaction in smaller social scales such as households and lineages.

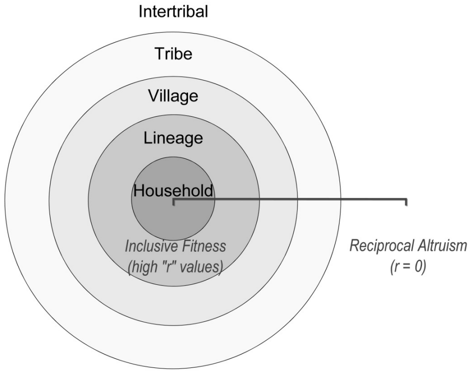


Figure 2.2. Comparison of Sahlins' (1972) reciprocity sectors, degrees of genetic relatedness, and areas in which Hamilton's (1964) Inclusive Fitness theory applies versus the areas in which Triver's (1971) Reciprocal Altruism theory predominates.

This reserves reciprocal altruism for the dominant role in social interaction between groups. Reciprocal altruism already provides foundations for much of our interaction with others—from the formation of friendships and alliances (Tooby and Cosmides 1996) to the practice of warfare (e.g., Chagnon 1988; Tooby and Cosmides 1988). Reciprocal altruism is the means by which relationships are created through gifts, explaining both Mauss' power and Levi-Strauss' unconscious mental structures. Exchange occurs between non-related individuals through the equation of $c < bw$, with an expectation of return benefit for the actor and the creation of obligation for the recipient.

Predictions

The value of such a synthesis of evolutionary and sociocultural perspectives is that it allows us to make predictions about the development and operation of exchange systems and networks. Seven predictions follow from this synthesis:

1. The pervasive nature of social interaction through reciprocity and cooperation across human societies suggest that it is an evolutionary stable strategy that utilizes a tit-for-tat strategy and has mechanisms to measure trust and prevent counteracting cheating strategies (Axelrod 1984; Axelrod and Hamilton 1981; Chisolm 1993; Cosmides and Tooby 2005; Tooby et al. 2006)
2. Cooperation and exchange between non-related individuals is conducted to meet selfish objectives. In other words, individuals are seeking to promote their own interests through exchange and interaction with others. This follows directly from reciprocal altruism and game theory explanations of cooperation, as well as Durkheim's much earlier insightful observation that organic solidarity was formed through the cooperation of unlike

individuals pursuing their individual interests (Axelrod 1984; Axelrod and Hamilton 1981; Durkheim 1964; Trivers 1971).

3. Social exchange networks can be used to enhance fitness by establishing relationships and accumulating obligations from others (Axelrod and Hamilton 1981; Durkheim 1964; Gregory 1982; Gosden 1989; Hayden 1995; Levi-Strauss 1969; Mauss 1990).
4. Individuals exploit the tit-for-tat strategy through the exchange of gifts and other materials. The degree of trust, or "*w*" of the reciprocal altruism equation, is measured by the degree to which gifts are reciprocated. Cheaters can be detected through this process, and the potential beneficial advantages of the relationship can be estimated through an iterated cycle of reciprocal exchange. The adaptive advantage of exchange can then be modeled in terms of costs, benefits, and degree of expected return, measured through such variables as energy, time, or social status (Cosmides and Tooby 2005; Tooby et al. 2006; Trivers 1971).
5. The initial exchange between new or infrequent partners is risky, since '*w*' has not yet been modeled or is modeled poorly. As a result, rules affecting interaction are likely to be developed. The materials or form of exchange may be prescribed and proscribed within a ritual context, which minimizes risk and maximizes potential return (Axelrod and Hamilton 1981; Foster 1977; Görlich 1998; Levi-Straus 1969).
6. Exchange replaces the spatial juxtaposition of non-interacting groups and individuals with a relationship, for better or for worse. As Levi-Strauss (1969:59) observed, "the relationship of indifference can never be restored once it has been ended… From now on, the relationship can only be cordial or hostile." Predictions that follow from this observation involve the range of responses that reflect the interacting parties'

interpretations concerning the strength of '*w.*' If '*w*' is found to be strong enough to convey significant benefits, interactions may become more frequent as participants seek fitness opportunities that carry lower risk and are more likely to convey benefits. If repeated cycles of reciprocity lead to high estimations of trust, interaction may proceed from one based on reciprocity to one based on mutualism (Tooby and Cosmides 1996), or it may lead to Levi-Strauss' (1969) and Williams' (1969) 'supreme gift' of women in marriage exchange. This also leads out of reciprocity-based relationships as trust is replaced with a shared interest in the other parties reproductive fitness (Hamilton 1964), further strengthening the relationships between groups and individuals. If such relationships are of lasting benefit between groups, rules affecting out-group marriage, or exogamy, may develop. By this logic, the formation of exogamy and possibly corporate kin structures are linked to earlier reciprocity-based social exchange.

However, the relationships may not always lead to strengthened values of '*w.*' The failure to adequately reciprocate could lead to lowered estimations of '*w.*' In such cases, Durkheim (1964), Gregory (1982) and Levi-Strauss' (1969) observations concerning the inherent conflict of exchange illustrates the cooperate/defect dichotomy inherent in game theory's model of cooperation. If '*w*' is weak, a defect strategy that emphasizes personal gain while imposing a cost on others is advantageous if the partners do not anticipate future interaction or cooperation (Axelrod 1984; Axelrod and Hamilton 1981; Görlich 1998). In other words, interpersonal and intersocietal conflict, negative reciprocity, and warfare are predictable outcomes of failed exchange systems and/or inept "calculators."

7. Finally, the use of reciprocal altruism and kin selection models allows social exchange to be modeled using cost-benefit analyses similar to other optimality models of human behavioral ecology (e.g., Winterhalder and Smith 2000). The adaptive advantage of exchange networks can be modeled in terms of costs, benefits, and degree of expected return using energy, time, or social status gained or lost as proxy currencies.

Modeling the Adaptive Nature of Social Exchange

The preceding discussion illustrates the important role of social exchange and interaction in forging, monitoring, and maintaining relationships, and enhancing participants' fitness. As such, it casts these activities as part of the evolved human behavioral repertoire, and thus subject to some degree of modeling using optimality theory.

Life History Theory and Optimal Foraging offer two approaches to studying human behavior within conditional strategies, or systems of decision making rules, in which natural selection is thought to have favored the development of behaviors that tend towards the optimization of somatic and reproductive effort (Bentley et al. 2008; Chisolm 1993; Stephens and Krebs 1986; Winterhalder and Smith 2000). These models derive from microeconomic theory which examines how individuals make decisions concerning the allocation of limited resources (Keegan and Butler 1987; Winterhalder and Smith 1981, 2000). According to these models, humans have an evolved ability to weigh the costs and benefits of their current and potential future actions in such a way as to optimize their return. This optimality is seldom achieved—human behavior and the variables of social interaction are quite complex and often offer conflicting options—but modeling optimality provides a mathematical and graphical heuristic for identifying behaviors, the factors that affect those behaviors, and reasons for variation from optimality.

The model that follows is built upon the predictions outlined above, and assumes that: a) individuals have limited resources in several forms—including time, energy, and social capital—and they act to optimize their return in several socially, somatically, and reproductively valuable areas; b) optimization is not just concerned with the number of calories that can be returned per calorie of labor invested, but must factor in *all* the conflicting needs that individuals must meet to optimize their fitness; c) decisions about investment of time, energy, or social capital attempt to balance all these conflicting needs, thus time invested in one area, say food procurement, is in direct competition for time invested in other areas such as gaining social capital, finding mates, parenting, or other socially meaningful activities. In the model to follow, social exchange and interaction networks consist of individuals who are united through the acts and obligations of exchange, and these relationships are between individuals in different communities or societies interacting through reciprocity. This model is not intended to describe the complex relationships found within communities which may be based on inclusive fitness, mutualistic relationships, reciprocity, or various complex interactions of all three.

Benefits and Costs

By using an optimality model, the benefits of exchange can be identified in relation to the costs of forming and maintaining exchange networks, and the trade-offs those costs demand in terms of other somatic or reproductive efforts. The currency of costs and benefits may be highly variable, and can range from time and energy invested and returned to social status gained or lost.

Following the predictions discussed above, exchange networks can be viewed as one means of increasing personal fitness through the development and maintenance of relationships of cooperation, obligation, and reciprocity with others. They are, in this view, a means of intensifying resource exploitation—or to paraphrase the terminology of Optimal Foraging Theory, increasing 'resource breadth'—in which relationships with others are viewed as a resource that can be exploited for personal gain. However, developing such relationships requires time, resources, and energy that could be used for other activities that may have more immediate benefits. Therefore, the time, energy, resources, or social status invested in creating and maintaining these networks must have an anticipated future benefit in socially meaningful currencies which could include the acquisition of resources or knowledge, increased social status, reduction of risk, or access to marital partners. These benefits have been shown to correlate with increased survival and reproductive opportunities by research with modern communities (e.g., Betzig 1986; Buss et al. 1990; Buss and Schmidt 1993; Kenrick et al. 1990; Marlow 2004).

Additional resources can be used directly for somatic benefit, provide associative value in the form of access to the exotic or rights of spiritual intercession, or may provide more indirect benefits in the form of status gained. Resources need not even be physically gained since the acquisition of the 'obligations of others' serves as an investment for future benefit (Gosden 1989; Gregory 1982). While resources gained may provide an immediate somatic benefit, male access to resources has been strongly correlated with reproductive success in cross-cultural studies (Buss and Schmidt 1993; Kenrick et al. 1990; Marlow 2004).

Status can also be gained through the development of social networks. Access to exotic, distant, and rare materials; to knowledge and distant contacts, or to the spiritual, can confer important distinctions on individuals. Individuals who develop bridges between separate spheres of interaction and exchange can gain from their position as the source of benefits that others in the community seek (Barth 1966:18; Granovetter 1973, 1983). Further, by developing networks that provide benefits to others in the community through access to materials or knowledge, individuals become critical and irreplaceable pathways on which others in the community rely. Status and irreplaceability are both important means of improving survival and reproductive success as many researchers have demonstrated (e.g., Betzig 1986; Buss et al. 1990; Granovetter 1973, 1983; Tooby and Cosmides 1996).

I previously argued that the estimation of trust or potential future benefit is initially a goal of incipient exchange networks, and that reciprocation can lead to positive values of "*w*" which may, in turn, lead to a progression of the relationship from one based on reciprocity to one based on exchange of females in marriage. As noted by Williams (1969:166-169) and Levi-Strauss (1969), this is the 'supreme gift' in exchange networks; a gift that strengthens the relationship from one based on reciprocity to one with kinship ties and vested interests in the reproductive and somatic success of the other. This has long lasting benefits ranging from the simple access to potential spouses, to the creation of affines and strong alliances that provide for reduction of risk through food sharing (Hegmon 1991, 1996), fostering and maintaining peaceful relations (Williams 1969), protection from warfare and aggression, and increased survival rates of children.

These are a few of the more important benefits to be gained through the development of exchange networks. The costs are perhaps harder to model, but at a minimum include the time, energy, and resources needed to develop and maintain such networks, and the potential costs that failed networks may impose on individuals and their communities.

Establishing networks requires the resources necessary to either offer gifts or to reciprocate the offers of others. These costs are relative and variable, and will vary from individual to individual in a community depending on their ability to acquire valued resources or to control or channel the production of others. Certainly a scenario can be envisioned in which limited resources would make the costs of participating in exchange networks prohibitively expensive. Likewise, scenarios can be envisioned in which some individuals would find exchange networks to be a worthwhile investment, especially where an individual has access to resources desired by others, they have access to existing relationships where the anticipation of return benefit is high, or where they have the ability to direct the productive efforts of others either through kinship or other persuasive means.

However, failed exchange networks entail a risk not only to the individual, but to the larger community. This cost—the potential risk created by failure to reciprocate and ensuing agonistic behaviors of others—must be considered but may be subject to mitigation in at least two forms. The first is the development of ritualized contexts of exchange which proscribe the development of exchange networks and the types of allowed gifts and reciprocation that are offered. Thus, gifts or exchange rules and materials may become standardized, such as the rules governing the Kula (Malinowski 1961), gifts may be imbued with spiritual meaning, such as *hau* among the Maori (Mauss 2000), or both may operate simultaneously. The second mitigation is less direct and is predicated upon the observation that the agonistic behaviors of others can lead to benefits as well; they open the possibility of socially sanctioned negative reciprocity and warfare. While warfare certainly imposes costs, it also provides an alternate pathway for individuals to gain status and/or reproductive benefits (Chagnon 1988; Tooby and Cosmides

1988). Individuals entering into risky exchange networks may discount the potential costs of failed exchange by anticipating the potential benefits of warfare.

Modeling Exchange Benefits

As mentioned previously, differential access to social networks exists within societies. Due to defined territories, availability and density of existing networks, consanguineal and affinal relationships, numbers of kin and the ability to control production, personal skills and abilities, social rank, and other factors, some individuals will have greater, and earlier, access than others to the benefits of exchange networks (Asad 1972; Barth 1956, 1966; Kapferer 1971:15).

At certain thresholds, it becomes advantageous for those individuals to use exchange networks to expand their 'resource breadth' rather than pursue other resource acquisition means, such as changing mobility or intensifying or broadening resource exploitation. Thresholds define the points at which exchange networks become viable strategies. These consist of two distinct categories—resource costs and benefits, and the accessibility of viable networks.

In optimality approaches, the net benefit capture can be limited by several factors that may be grouped into the three categories of time limitations, energy limitations, or hazard limitations. Expanding the benefits gained from any one particular strategy may run into conflicts with time needed for other activities (time-limited), require more energy than the benefit justifies (energy-limited), or may expose the individual(s) to greater hazards from risks (hazard-limited) inherent in the strategy (Charnov 1976; Winterhalder and Smith 2000). In short, the net gain per unit of investment decreases per unit time, thus intensifying the exploitation of resources involves increasing costs and decreasing rates of benefit return. As an example, Figure 2.3 demonstrates the decreasing rates of energy return from expanding diet breadth to include increasingly higher cost and lower benefit small grain resources native to eastern North America (data from Gremillion 2004). Expanding diet breadth to incorporate new wild grain species in the diet will yield additional calories but at an increasing cost in procurement and processing time and energy (e.g., Gremillion 2004). Thus the energy return gained through intensification efforts is discounted by increased energy and time invested in procuring those resources. In other words, resources become more costly.

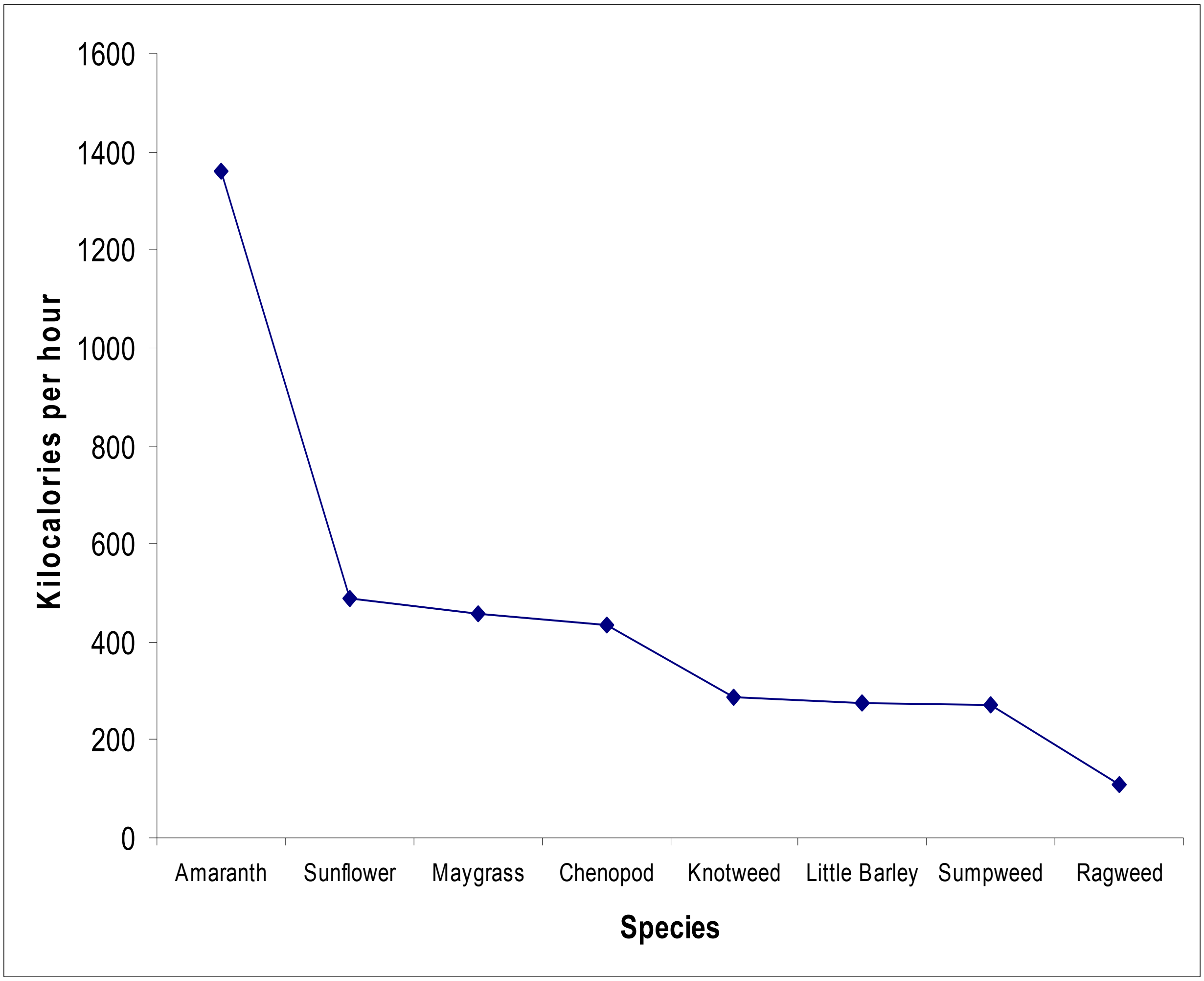


Figure 2.3. Decreasing return rates associated with wild grains utilized during the Archaic period in eastern North America (after Gremillion 2004:Table 4)

The accessibility of viable networks is another critical threshold value. In this sense, thresholds are defined by the number of individuals that must already be combined in networks, and the accessibility of these networks to new individuals (Granovetter 1978). In some cases this may be dependent on population density—raising the old issue of population density as a driving force behind increasing interaction and social complexity—but this is not the only way in which network thresholds can be achieved. Conceivably, network thresholds can be approached in at least two non-exclusive ways; internally-generated and externally-generated. Internally-generated thresholds come from increasing interaction within and between communities across small social distances, and represent the expansion and increasing integration of local exchange systems from within. Such expansion and integration can lead to increasing network accessibility to individuals in those communities, and may be associated with decreasing risk of non-reciprocation since '*w*' is more effectively modeled. Internally-generated thresholds will likely to be linked in some cases to increasing population density. On the other hand, thresholds can be achieved without increasing population density in the case of externally-generated thresholds. Exchange networks may have their origins in areas far distant from some regions they come to characterize. For example, in the Archaic of the North American midcontinent, exchange systems eventually incorporate the region from the Great Lakes to the Gulf Coast, and the Appalachians to the Great Plains. Yet populations need not be high in all those areas. Exchange systems can originate in one or a few areas—say the Ohio Valley or lower Mississippi Valley in this example—and then expand outward through the fitness enhancing behaviors of individuals around the network peripheries. As networks become increasingly interconnected and integrated, they simultaneously become more productive sources of benefits for those located around their peripheries. Thresholds in more distant areas are thus exceeded even without increasing local population densities, as distantly generated exchange networks become more integrated and available to peripheral areas and thus provide more viable benefits to people who are in a position to access those networks. Network theory demonstrates that such networks can be generated without deliberate or purposeful action and may feature the rapid development of structural properties such as the sudden appearance of large network systems known as "giant components" (Achlioptas et al. 2009; Bohman 2009). In a sense, this is the development of a network infrastructure that, through bridges connecting several local spheres of exchange, provides access to distant materials and ideas. Such an infrastructure is the foundation of Renfrew's (1972) "down the line" model of exchange, in which materials move from hand-to-hand through local systems, ultimately moving large distances over multiple transactions. However, the number of transactions needed to move materials and knowledge over long distances may be limited, as it is the few individuals that form bridges between local spheres of exchange that power such systems (Kochen 1989; Milgram 1992; Travers and Milgram 1969; Watts 1999)

As thresholds are reached, those individuals with access to developing exchange networks reach a point at which exploiting exchange opportunities will yield a greater potential benefit to their fitness than further intensifying resource exploitation. This can be modeled as shown in Figure 2.4. As benefits from existing resource strategies decrease due to increased time or energy costs, and as thresholds of network interconnectedness are exceeded, individuals with access to those networks would realize a net benefit gain by utilizing exchange systems to build and maintain relationships with others who have access to socially meaningful resources. At that point, optimality suggests that those individuals will switch strategies to exploit exchange networks.

Note that a change in the value or return rate of resource methods can dramatically alter the benefits to be gained through exchange networks. Technological changes in processing or procurement methods can increase the return rate for some resources, while the adoption of new strategies such as agriculture can dramatically alter the above model. This does not need to occur everywhere within a growing network, as a disruption in the connectedness of a network in one area can alter the value of that exchange networks to participants in more distant areas.

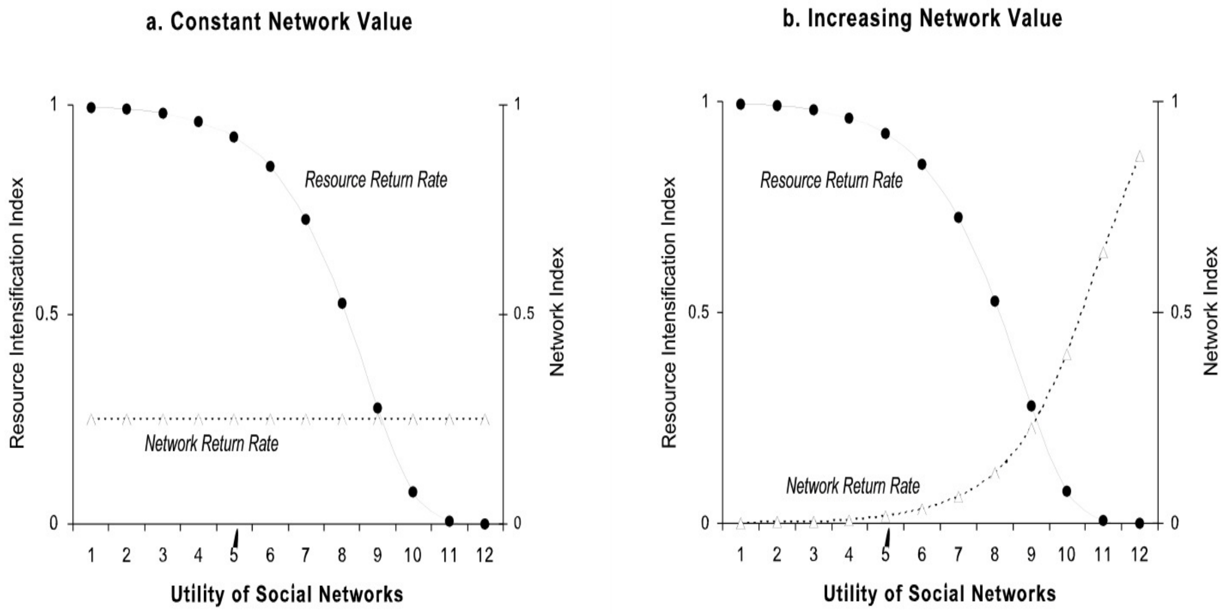


Figure 2.4. A proposed optimality curve for exchange network benefits. Two models are presented: in a) the benefits of network participation remain constant while other resource values decline; b) shows the predicted increasing network benefits as a logistical curve that reflects increasing network interconnectedness and access.

Testing the Adaptive Networks Hypothesis

Several predictions follow from the outlined hypothesis which may be tested using archaeological data. In particular, the hypothesis first predicts that certain individuals will have access to viable exchange strategies before others in their community and second, they pursue exchange networks to promote their own interests and enhance their fitness. Their interest and fitness benefits come in many forms, including increased access to resources, and status from access to the exotic as well as serving as ‘brokers’ in their community. Barth (1966) describes ‘brokers’ as providing important links in exchange networks, links that form bridges from one exchange system to another. Granovetter (1973, 1983) later identified, clarified, and defined this same phenomenon through social network theory, and labeled it the ‘strength of weak ties.’ These bridges, for example the A-B segment in Figure 2.5, provide the connections that connect smaller more completely integrated networks, equivalent to communities or societies in this discussion, into larger systems. To further stretch the bridge metaphor, the individuals at each end of the bridge extract a toll from the materials and information flowing through this link—they become irreplaceable (Tooby and Cosmides 1996) as sources of socially valuable material and gain benefits from this position. In this example, the individuals represented by A and B are those individuals for whom the network benefit threshold has been met and who stand to gain benefits through forming exchange networks. A testable aspect of this model is to examine the association between materials transmitted through exchange and reproductive fitness (e.g., Hayden and Schulting 1997)

Finally, following the uncertain nature of trust and the consequences of non-reciprocation, exchange is risky not only to participants but to the community at large. Consequently, mitigation of risk is likely to have involved rules concerning standardization of exchange materials and practices, and placing the practice of exchange within a ritualized context.

Archaeological data can be used to explore these aspects of the hypothesis by formulating the following questions. First, does the presence and nature of exotic materials suggest that the exchange benefit thresholds have been crossed and exchange is a viable strategy for some members of the community? Second, are the benefits of exchange networks widespread in the community, or, as predicted, limited to a few 'brokers'? Third, do those brokers demonstrate greater fitness or social position than other community members? Finally, is there a standardized or ritualized context for exchange that may serve to mitigate risk and optimize potential benefits? These questions are addressed in the following chapters.

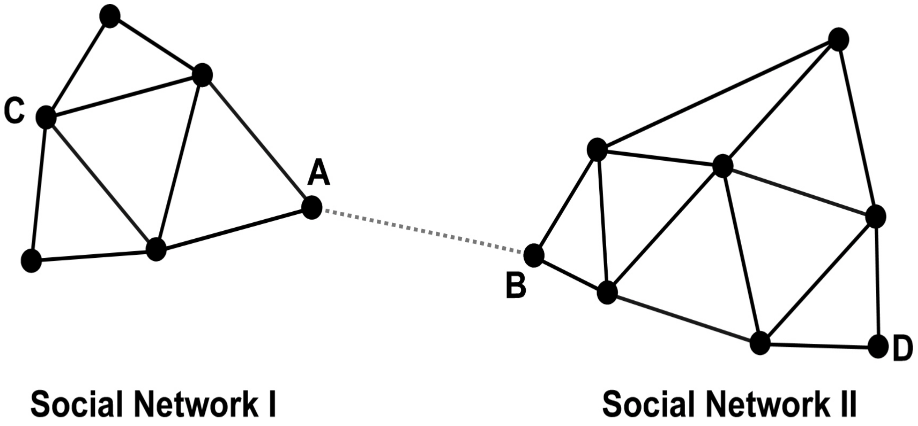


Figure 2.5. Graph Theory representation of the bridging effect, or the 'strength of weak ties', connecting two local networks. The A-B segment represents the exchange link between two local networks or communities, and the individuals represented at A and B are the brokers through which material and ideas flow from one network to the next.

Testable Implications

Due to its foundation in evolved human behavioral traits, the adaptive network hypothesis provides a useful tool for examining the development of exchange networks. By viewing the development of exchange networks from the perspective of individual fitness benefits, the hypothesis' utility lies in its ability to form testable predictions of individual behavior and the emergent phenomena the result from collective fitness enhancing behavior.

The model predicts that at certain threshold points, some individuals will find exchange networks to be a beneficial strategy. Those individuals will engage in exchange in order to enhance their fitness, and may gain benefits in the form of access to material and ideological resources, enhanced social status, social roles as brokers of information and goods to their community, reduction of risk, access to potential mates, and the formation of alliances that can provide further benefits. These benefits come with the risk of non-reciprocation and potential agonistic responses. These risks will be mitigated through social sanctions that prescribe contexts and materials of exchange, and may be further mitigated by anticipating the benefits of alternate strategies such as warfare.

These observations allow for the development of explicitly testable predictions, and provide an important tool for examining the development and functioning of emergent phenomenon, such as regional exchange networks, using archaeological data. Five testable implications emerge from this model.

First, some individuals and some communities are predicted to have greater access to exchange networks and their benefits. The entire community may be too isolated, either geographically or socially, from exchange networks with the result that it is too costly to engage in exchange from that community. In these communities, we expect to see few exotic goods, and exotic goods that are present should appear to result from informal down-the-line exchange rather than intensive and directed interaction with other communities. In other cases, some individuals within a community will have greater access to the benefits of exchange. In this situation, mortuary contexts should reveal the presence of haves and have-nots in the form of differential interment with exotic goods.

Exchange is risky and risk is shared by the entire community. Earlier, this observation was used to suggest that social rules would likely develop which prescribed the type of exchange goods and which exchange is embedded in ritual or formal contexts that serve to reduce risk. In particular, materials exchanged may be standardized in terms of raw material or production criteria to provide clear, understandable, and verifiable *costly signals* (Bird and Smith 2005) of trustworthiness and veracity across large social distances. This can be identified through analysis of the metric attributes, raw material selection, and production methods of goods that appear to prominently function in exchange over large social distances.

When exchange validates trust, increasing interaction should occur as benefits increase and potential costs of conflict decrease. Also, as benefits increase, networks may become more robust and facilitate the movement of materials over longer distances. These potential results will be visible in the form of increasing frequency of exotic goods through time as well as by an increase in the distance from which exchange materials are obtained.

However, the failure of exchange networks may lead to increased conflict as trust is not reciprocated. This may be visible in several forms. First, an examination of mortuary populations may show increasing trauma or changes in demographics that suggest interpersonal violence. Conflict may also be visible in the form of sites of battle or massacre, or in increasing reliance on defensive structures or site locations.

Finally, changes in social structure may result from increasing interaction with other communities through exchange. As trust is established through iterated cycles of exchange, relationships may be strengthened through the formation of new inclusive social structures, such as corporate groups, and eventually through intermarriage with other communities. William's (1969) exogamy rules may even develop in certain situations as individuals and communities experience important benefits through inter-community cooperation. These changes may be observed through analysis of mortuary populations and, in particular, changes in the social roles and positions of adult females and children that may signal the development of corporate groups or rules of exogamy.

These implications, as summarized below in Table 2.1, form the core of this study. In the following chapters, each will be explored using mortuary data, an analysis of the metrics and production methods of exchange goods, visual and chemical sourcing of materials featured in interaction networks, and changing frequencies of exotics through time.

Table 2.1. Conversion of model predictions to testable implications and methods.

Model Prediction	**Testable Implication**	**Method**
Differential Access within community	Differential distribution in the population	Analysis of mortuary populations
Differential access between communities	Differential distribution between sites	Frequency of exotics per site
Exchange is Risky	Standardization of exchange materials to convey clear signals across large social distance	Analysis of metrics, production methods, and materials of exchange goods
Frequency of interaction may increase as trust is established, risk is lowered, and benefits become more accessible	Frequency and scale of exchange may increase through time	Analysis of the frequency and source distance for exchange materials in components representing sequential time periods
If trust is established through interated cycles of exchange, relationships may become based on mutualism and ultimately on kinship through exchange of females in marriage	Change is social structure to feature corporate groups and changes in role of females and children as they take on new role in creating relationships through kinship	Mortuary analysis of populations in sequential time periods to explore changes in social structure and role of females and children vis-à-vis males
If trust is not reciprocated new strategies featuring imposition of cost on others may be adopted. Expect instances of negative reciprocity and conflict	Increased conflict will result in trauma or indications of warfare	Examine mortuary populations for indications of trauma or warfare

CHAPTER THREE

ENVIRONMENTAL SETTING

Small scale societies on every continent have developed interaction networks and systems of inter-community exchange that have contributed to increasingly complex forms of social organization, and the study of this process could be accomplished in many ways. Broad-scale cross-cultural approaches could be used to examine the phenomenon around the world, or more in-depth specific examples could be used to examine individual examples in detail. This study takes the second approach and focuses on a specific time and place in which social networks develop and expand to regional and continental scales, and in which societies appear to develop increasing layers of social complexity and inequality.

As we will see later in Chapter Four, these events correspond with the Archaic period in the North American Midcontinent. This study has its origins in the Late Archaic Duck Lake site in the upper Great Lakes, and staying true to this origin it will more broadly examine interaction among communities in the western Great Lakes during the period from around 4000 to 2000 years ago. The western Great Lakes study area is a broad region bordered by Lake Superior on the north, Lake Michigan on the east, and the Mississippi River on the west (Figure 3.1). As will be shown in subsequent chapters, much occurs here in the Late Archaic—from the establishment of exchange systems that move goods from distant sources throughout North America, to the elaboration of mortuary ritual, to the development of regional systems of shared ritual, style, and beliefs. Monumental architecture makes its first appearance late in this period, and experiments with cultigens also begin at this time. But before we examine these social events in more detail, we must first set the stage by examining the environment of this region, including its context in the North American continent, its major features, climate, resources, and late Quaternary development.

This environment varied greatly throughout the early Holocene as the climate and water tables changed following the end of the Pleistocene, yet by the beginning of the study period the levels of the Great Lakes become less variable following the abandonment of the Chicago and North Bay outlets by 4000 B.P. (Larsen 1999:28). Climate fluctuated somewhat, with a warmer and drier period dating between 4500 and 3500 BP and cooler moist period from 3400 to 1500 BP (Kapp 1999), yet a cautious and informed use of the modern environment allows for an approximation of the landscape encountered by Archaic populations. This landscape and the subsistence resources it supports help structure the nature of human adaptations and population distribution during this period. The distribution of resources such as lithics and copper contribute to the nature of exchange between communities and allow us today to understand the source of exchange materials. Major features such as rivers, shorelines, broad environmental divisions, and watersheds contributed transportation routes and incentives for interaction between communities over long distances.

Context

Eastern North America is dominated by three major watersheds: the Atlantic, the Gulf Coast, and the Arctic. The study region sits astride the divide between two of these: the Great Lakes – St. Lawrence watershed and the Mississippi watershed (Figure 3.1). Each of these is a significant natural corridor through which plants extend their ranges northward and westward, animal species migrate, and people can establish contacts and relationships with other distant groups

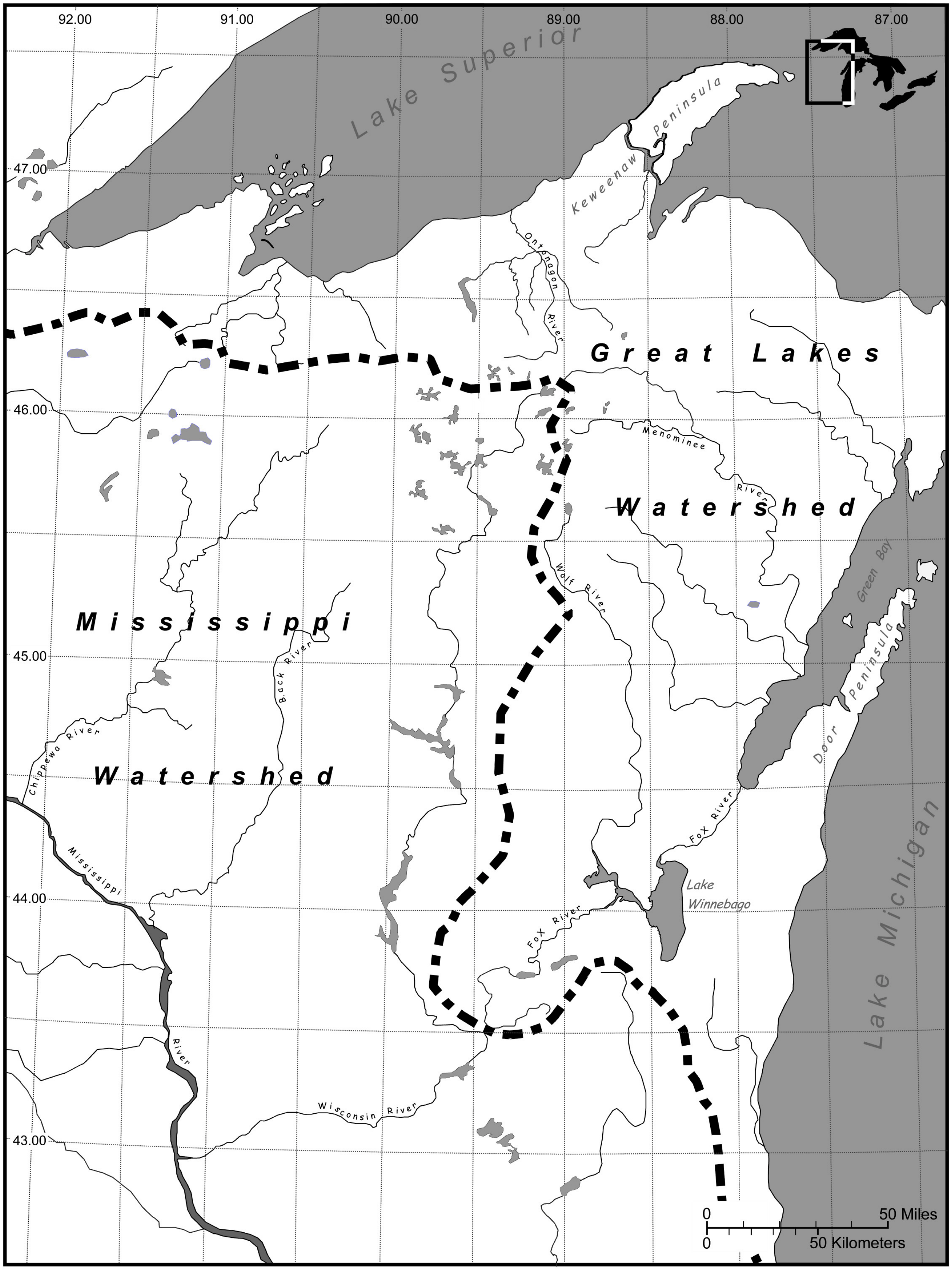


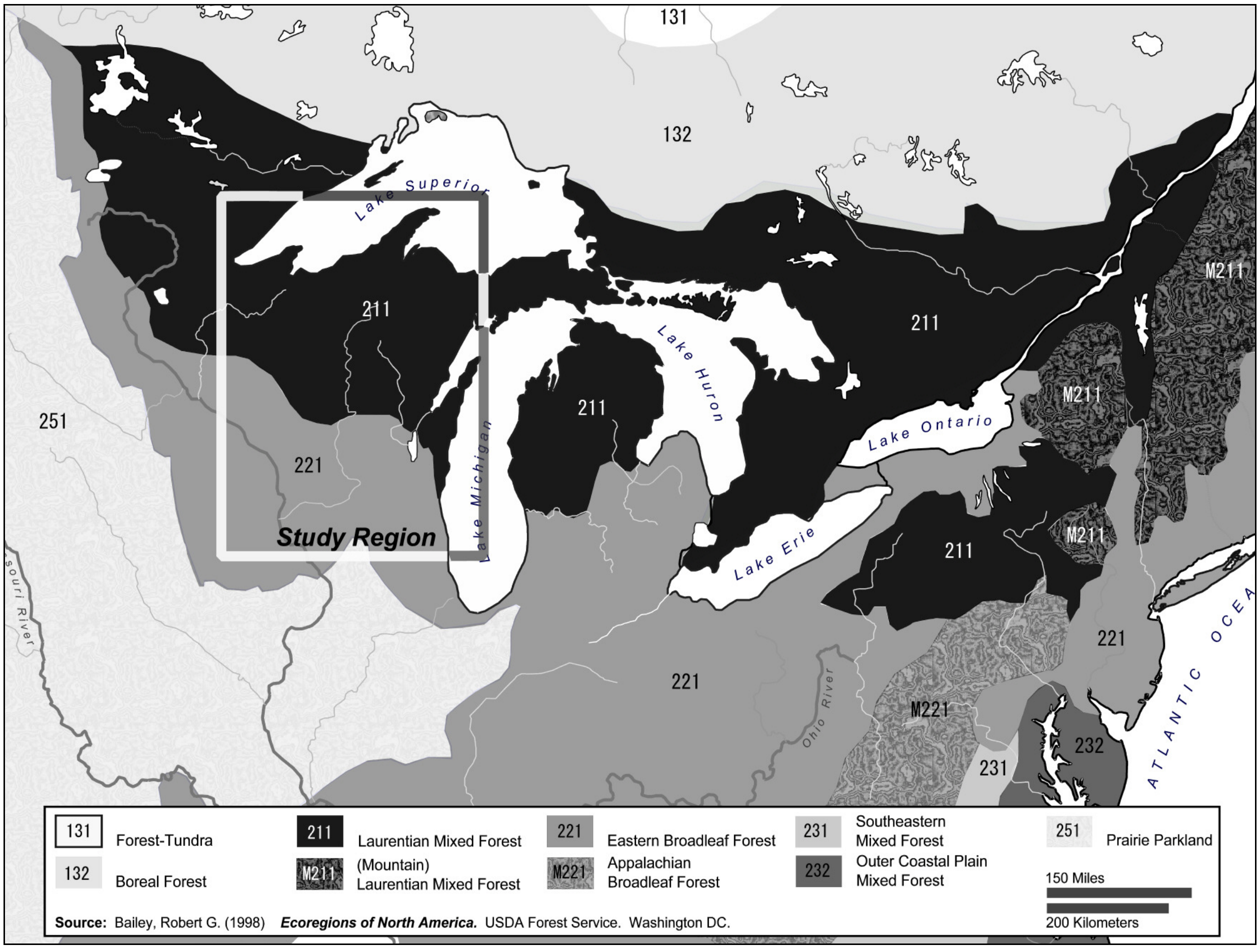
Figure 3.1. Mississippi and Great Lakes watersheds in the study area.

with relative ease. The Mississippi Valley and its tributaries provide northern societies with a corridor through which ideas and goods can move from the Ohio Valley, the Gulf Coast, and more distantly the Great Plains via the Missouri and Minnesota Rivers. Likewise, the Great Lakes and St. Lawrence River provide access to ideas and materials from the lower Great Lakes and the more distant Atlantic Coast of Canada and New England.

While these two watersheds provide relative ease of access to distant ideas and resources, there are other barriers that must be considered. Of these, environmental conditions are perhaps preeminent. Eastern North America supports a wide diversity of ecosystems, from arctic and subarctic in the north to subtropical and tropical in the south. Climatic conditions affect the distribution of these ecosystems, including the movement of marine and continental air masses, the amount of solar radiation, and the amount and seasonal distribution of precipitation (Bailey 2002:235).

Building on the work of Köppen (1931) and Trewartha (1968), Bailey (1998, 2002) has used a combination of climatic conditions and vegetative communities to subdivide the North American environment. The study region lies entirely within the Humid Temperate domain, which comprises the eastern United States and extreme south central and southeastern Canada, and which is characterized by the interplay of polar and maritime air masses, forests of broadleaf deciduous and conifer trees, and pronounced seasons. The Humid Temperate Domain has been divided into six divisions based upon the amount of winter frost (Bailey 2002:238-240), two of which—the *warm continental* and *hot continental*—are of direct interest to this study (Figure 3.2).

In the Great Lakes, the warm continental division stretches across the northern half of the region and is known by many names including Lake Forest (Papworth 1967), the Conifer-Hardwood



Source: Bailey, Robert G. (1998) *Ecoregions of North America.* USDA Forest Service. Washington DC.

Figure 3.2. Ecoregions of northeastern North America (Adapted from: Ecoregions of North America, Bailey 1998).

Forest (Benchely et al. 1997), the Transition Forest (Sutton and Sutton 1988), and Laurentian Mixed Forest (McNab and Avers 1994). The climate is characterized by strong seasonal contrasts with long, cold, snowy winters and short relatively warm summers. Precipitation falls year-round, but is greater during the summer. Vegetative communities are a mix of coniferous and deciduous species including maple, birch, white pine, and spruce that typically form closed canopy forests except where disturbed by wind or fire. Soils are stongly leached, acidic, and deficient in calcium, potassium, and magnesium making them poorly suited for agriculture (Bailey 2002:240). This ecosystem, with regional variations, extends from northeastern

Minnesota and southern Ontario across the Great Lakes and down the St. Lawrence River to northern Maine, New Brunswick, and Nova Scotia, thus providing internally consistent environmental conditions from the north Atlantic coast to the midcontinent.

South of the warm continental division lies the hot continental division. Here, deciduous Eastern Broadleaf forests of oak, hickory, and other species grow in closed canopy communities, occasionally punctuated with pockets of tallgrass prairie. Similar to the warm continental division, the hot continental division features a climate with distinct seasons and ample precipitation. However, summers are considerably longer and warmer, and precipitation falls more heavily in the spring than in summer. The diversity of faunal species is greater than in the mixed forest to the north. Soils are moderately leached ultisols and alfisols, rich in humus and minerals and generally well suited to agriculture (Bailey 1998, 2002:240). Particularly important is the fact that this ecosystem provides internally consistent conditions from the southern Great Lakes, to the Ohio Valley and much of the mid and upper Mississippi Valley, while differing in species and climate from the more northern forests of the study area.

Therefore, the study area occupies the headwaters of two of the continent's greatest natural corridors; the Mississippi and Great Lakes-St. Lawrence waterways. Environmental conditions connect the southern portion of the study area to much of the midcontinent, including the Ohio and Mississippi valleys. The mixed forest environment of the northern portion of the study area links it through the Great Lakes to the St. Lawrence River and North Atlantic coast. Thus, this region is a continental crossroads where ideas, people, and resources from the south can interact with those from the north and east, creating an important opportunity to study the movement of such ideas and resources during the Late Archaic.

Major Physiographic Characteristics of the Study Area

The western Great Lakes is a diverse area of forests, lakes, rivers, glacial landforms, shorelines, and wetlands extending from the cold waters of Lake Superior to the resource rich waters of the Lake Michigan shoreline on the east and the environmental diversity of the Mississippi Valley on the west. It includes portions of the western Upper Peninsula of Michigan, and much of northern and central Wisconsin.

Lakes, Rivers, Watersheds

Several rivers cross the region providing habitat for fish, waterfowl, and other species utilized by the region's Archaic populations, as well as providing natural transportation routes connecting distant communities. Many of these rivers originate in the highlands south of Lake Superior. Over half of the area drains south and west into the Mississippi River. Most of the remainder drains south and east into Lake Michigan, while the extreme northern areas drain north into Lake Superior (Figure 3.1).

Originating at Lake Itasca in northern Minnesota, the Mississippi River flows south along the western edge of the study area. This section of the river flows through a heavily dissected upland plateau known as the Driftless Area that remained unglaciated during much of the Pleistocene (Martin 1965). High, steep forested bluffs overlook a wide valley through which the river flows past multiple forested islands, sand bars, and oxbow channels. This is a rich environment that supports a wide variety of terrestrial and aquatic fauna, and is a natural migration route (known as the Mississippi Flyway) for thousands of migrating waterfowl (Mississippi River Corridor Study Commission 1996:10). Much of the western half of the study area falls within the Mississippi watershed.

The Mississippi watershed is dominated by the 430 mile-long Wisconsin River. The Wisconsin begins at Lac Vieux Desert in the Northern Highlands, then flows south through the center of the region, eventually turning west and entering the Mississippi River at Prairie du Chien, Wisconsin. This major tributary is low gradient, and navigable by canoe for its entire length.

Two smaller major tributaries of the Mississippi, the Black and Chippewa Rivers, flow through the region. Draining much of the west-central portion of the study area, the Black River originates in the Northern Highland region and flows generally southward through the Driftless Area to join the Mississippi River at the town of LaCrosse, Wisconsin. From its origin in the Northern Highlands, the Chippewa River and its tributaries drain much of the northwest and north-central part of the study area before entering the Mississippi River between LaCrosse, Wisconsin and St. Paul, Minnesota. Sediment deposited by the Chippewa River forms a delta that protrudes into the Mississippi River, partially damming the river and forming three-mile wide Lake Pepin.

Lake Superior forms the northern edge of the study region. This is the largest freshwater lake in the world by surface area, and its great size means that the lake creates its own localized maritime climate, while its great depth (maximum depth 1,332 feet) and long retention time (191 years) historically keep the average water temperatures around 40º F (4.4º C). This creates a coastal climate that moderates both winter low temperatures and summer highs. It also creates conditions on the leeward shore where snowfall is accentuated by polar air masses crossing the lake and picking up moisture. As those air masses subsequently cross the southern shore and begin to rise over the highlands, orographic effects create zones of extreme snowfall called snowbelts.

Lake Superior is also the least productive of the Great Lakes. A relatively small watershed containing nutrient poor soils results in fewer dissolved nutrients for aquatic species. Nonetheless, over 39 species of fish native to Lake Superior, including lake sturgeon (*Acipenser fulvescens*), lake whitefish (*Coregonus clupeaformis*), lake trout (*Salvelinus namaycush*), and walleye (*Stizostedion vitreum vitreum*) all live and spawn in the lake (Goodyear et al. 1982).

The watershed of Lake Superior is relatively small, and only a narrow belt along northern Wisconsin and upper Michigan drains northward into this lake. Several small, high gradient rivers, including the Montreal, Black, Presque Isle, and Sturgeon flow from sources in the Northern Highlands over waterfalls and rapids to the lake. In the study area, the largest river system of the Lake Superior watershed is the Ontonagon River and its tributaries. Several branches of the river (East Branch, Middle Branch, Cisco Branch, and West Branch) originate from lakes in the Northern Highlands and flow generally northward until they meet the Keweenaw Highlands. At this point that they merge to pass through the Keweenaw range, forming the main branch of the Ontonagon River. The main branch is a low gradient stream that flows north for 40 miles before entering Lake Superior at the town of Ontonagon, Michigan.

The Keweenaw Highlands extend northward into Lake Superior, forming the Keweenaw Peninsula. These highlands form the southern edge of the Midcontinental Rift (or Lake Superior Rift), and are one of the geologic sources for raw native copper. Another peninsula, the Bayfield Peninsula, extends into Lake Superior on the north coast of Wisconsin. Off the tip of this peninsula is a unique archipelago of 22 islands known as the Apostle Islands that provides important spawning habitat for many of the more economically important fish species in Lake Superior, including whitefish (*Coregonus clupeaformis*) and lake trout (*Salvelinus namaycush*) (Goodyear et al. 1982).

Lake Michigan extends along the eastern edge of the study area. While its surface area of 22,300 square miles is smaller than Lake Superior, it has a watershed only slightly smaller and a fishery with greater productivity. Over 50 fish species are native to Lake Michigan, most of which spawn in shallow protected waters, reefs, or tributary streams (Goodyear et al. 1982).

The Door Peninsula is formed by the resistant dolomites of the Niagara Escarpment, and juts northeast from the Wisconsin shore into Lake Michigan. Green Bay occupies the basin between the peninsula and the mainland of Wisconsin and Upper Michigan. This bay supports a rich fishery, where multiple economically important species spawn in the shallow inshore waters and the lower reaches of rivers and streams (Goodyear et al. 1982).

Perhaps the dominant feature of the Lake Michigan watershed is the Fox River system. This system consists the upper and lower Fox River, the Wolf River and its tributaries, Lake Winnebago, and several smaller lakes including Lake Poygan, Lake Butte de Morts, Green Lake, and Lake Shawano. The Fox River has its source in south-central Wisconsin, from where it initially flows southwest until turning to the northeast only two miles from the Wisconsin River. From this point it is a gentle gradient stream that flows northeast through Lake Butte des Morts and into Lake Winnebago. At 28 miles long, 10.5 miles wide and with a surface area of approximately 215 square miles, Lake Winnebago is the largest inland lake in Wisconsin (Martin 1965:283). Lake Winnebago provides important habitat for Lake sturgeon (*Acipenser fulvescens*), walleye (*Stizostedion vitreum vitreum*), and other fish species. The west shore of the lake is low, while the eastern shore often features the high dolomite cliffs characteristic of the Niagara Escarpment. The lower Fox River exits Lake Winnebago at its northwestern shore, and drops steeply as it flows north over several rapids for 35 miles before entering Green Bay.

A major tributary of the Fox River is the Wolf River which has its source in the Northern Highlands. From there it flow south through Lake Poygan before joining the Fox River at Lake Butte des Morts. The upper Wolf River flows over a steep gradient of 10 feet to the mile and crosses multiple rapids, but the lower portion of the river has a gentle gradient of less than 0.5 feet to the mile.

The Fox River system, featuring Lake Winnebago and the Wolf River, has historically been a significant spawning area for Lake sturgeon (*Acipenser fulvescens*). In spring as the ice melts, adult sturgeon swim from Lake Winnebago into the Fox and Wolf Rivers where they spawn on hard substrate (gravel or rock) in rapids or other shallow fast moving water (Goodyear et al. 1982).

Several additional rivers, all originating in the Northern Highlands, flow southeast into Green Bay north of the Fox River system. The largest of these is the Menominee River, which is formed by the confluence of the smaller Brule and Michigamme Rivers and flows approximately 120 miles southeast to enter Green Bay between the towns of Menominee, Michigan and Marinette, Wisconsin. The river flows over a steep gradient of approximately 15 feet per mile, and features multiple rapids. Historically, the Menominee has supported large spawning runs of Lake sturgeon (*Acipenser fulvescens*), which entered the stream from Green Bay to spawn on the shallow rapids.

The Northern Highlands, where many of these rivers originate, is a unique landscape featuring hundreds of lakes, wetlands, and streams. This region is a southern extension of the Canadian Shield, and is comprised of an extensively worn peneplain at an elevation of more than 1000 feet above sea level. In places, remnant ridges of more resistant Precambrian rocks rise several hundred feet above the otherwise relatively level plateau of the Highlands forming low mountain ranges including the Penokee- Gogebic Range, the Porcupine Mountains, the Keweenaw Highlands, and Rib Mountain. Extensive late Wisconsinan glaciation buried much of the peneplain under terminal moraines, ground moraines, and outwash features, and left an immature drainage system with interconnected lakes, streams, and wetlands (Dott and Attig 2004; Martin 1965).

The density of lakes here is one of the highest on earth. In Vilas County, Wisconsin, 346 lakes occupy over 15 percent of the county, while marshes, bogs, and muskegs cover more than 20 percent more (Martin 1965: 413-418). Several of the lakes have no outlet and sit atop the watershed divide. Others drain north to Lake Superior, south and west to the Mississippi watershed, or south and east to the Lack Michigan watershed. These watersheds interweave through this watery landscape, at times even overlapping. For example, Lac Vieux Desert is normally the source of the Wisconsin River, but under high water conditions it also drains north through the Ontonagon River to Lake Superior.

These lakes and wetlands also provide habitat for fish such as the walleye (*Stizostedion vitreum vitreum*) and yellow perch *(Perca flavescens*), muskellunge (*Esox masquinongy*) and lake trout (*Salvelinus namaycush*). Moose (*Alces Americana*) and several species of waterfowl also rely on the wetlands and lakes for habitat (McNab and Avers 1994).

Ecosystems and climate

A significant ecotone separates the Eastern Broadleaf Forests of the southern half of the region from the Laurentian Mixed Forest of the north (McNab and Avers 1994). Each of these larger provinces is further subdivided into sections based on variations in bedrock, climate, landforms, soils and vegetation (Figure 3.3).

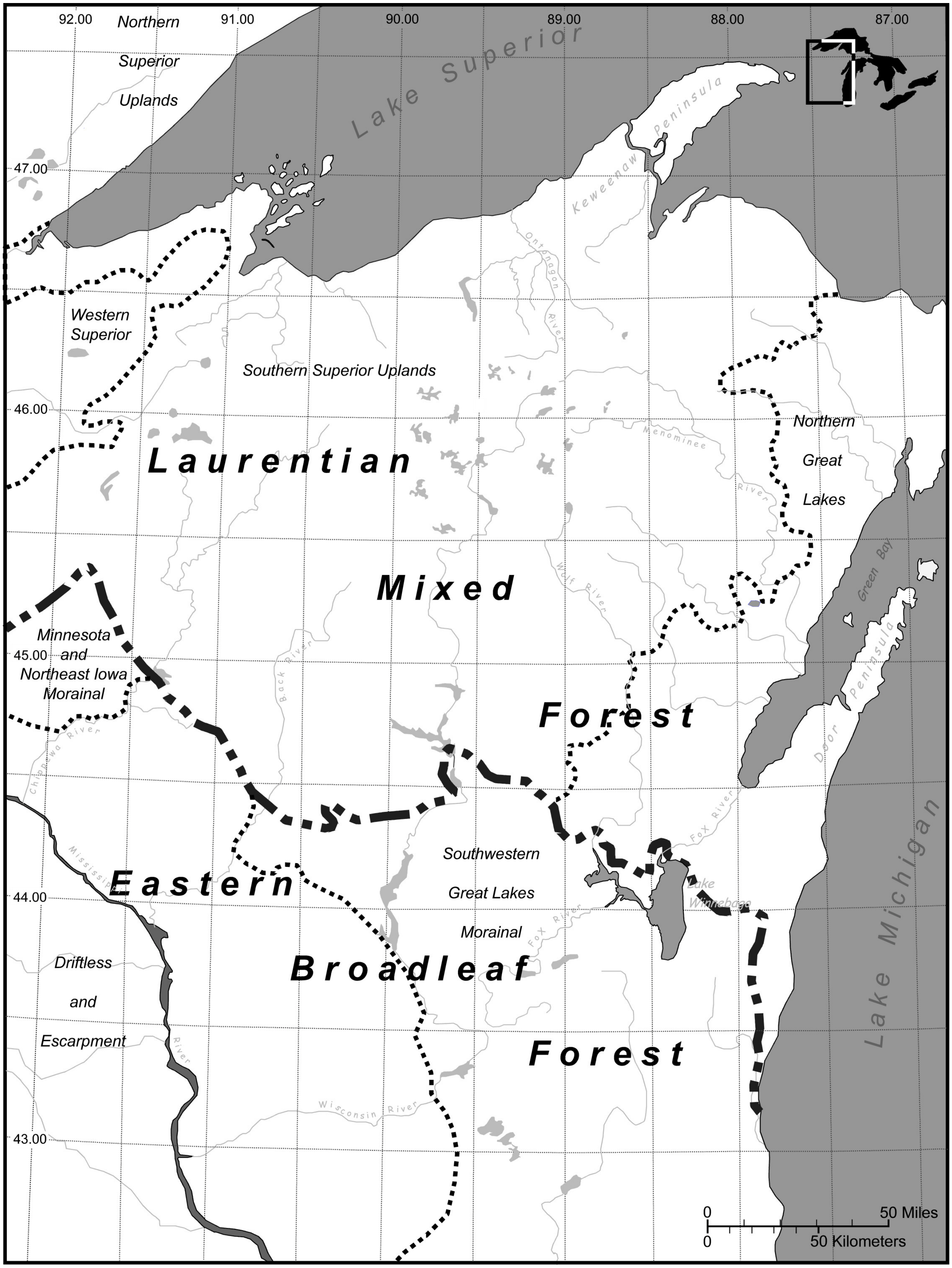


Figure 3.3. Ecological regions of the western Great Lakes.

The *Eastern Broadleaf Forest* province extends from the Ohio Valley and Ozark Plateau northward to the lower Great Lakes, and is part of the larger deciduous forest that characterizes much of the eastern United States. This is a region of deciduous species dominated by oak, hickory, basswood and maple forests. These forests grade into parklands in the southern region, eventually giving way to tallgrass prairie in extreme southern Wisconsin and northcentral Illinois. During the Wisconsin Glaciation, the eastern portion of this area, or *Southwestern Great Lakes Morainal Section*, was glaciated leaving multiple glacial landforms, while the glaciers missed the western portion, or the *Driftless and Escarpment Section*, along the Mississippi River. Climate is temperate and continental, with an average of 29-35 inches of annual precipitation. The dominant natural vegetation consists of oak savannah and lesser amounts of maple-basswood forests. Maple-basswood habitats increase along the more dissected valleys of the western driftless area. Dominant native fauna included bison and elk (prior to their extirpation in the 19th century), and deer in the early to mid-successional habitats created by fire and wind. The rivers and lakes support a variety of fish resources, including bass, pike, walleye, and sturgeon in the lower reaches of streams draining into Lake Michigan and in the Mississippi River and its major tributaries.

The Driftless and Escarpment Section along the southwestern portion of the study region is a maturely dissected upland plateau with steep sided ridges and hills up to 500 feet high (McNab and Avers 1994). The Mississippi River bisects the Driftless Section, forming a deep, broad valley which serves as a corridor for migrating waterfowl and habitat for numerous riparian and avian species. This area remained unglaciated during the Wisconsin glaciation, as is revealed by its high relief, mature drainages, and general lack of glacial features. Bedrock frequently outcrops along the steep sides of river valleys and escarpments. This bedrock consists of Cambrian sandstones; Ordovician dolomites, shales, and sandstones; and Silurian dolomites. Lithic resources such as galena and prairie du chien cherts are often exposed in bedrock outcrops, while higher "mounds" such as Silver Mound and the Blue Mounds may contain resources such as Hixton orthoquartzite (Behm 1980, Porter 1961) and Silurian cherts.

To the east, the Southwestern Great Lakes Morainal Section is characterized by flat to undulating glacial topography, with numerous drumlins, moraines, and eskers (McNab and Avers 1994). Much of this region was glaciated by the Green Bay and Lake Michigan lobes during the late Pleistocene (Dott and Attig 2004:245-250), resulting in a relatively young landscape with a low density of slow moving streams and a high density of glacially formed lakes. Much of the area is deeply blanketed by glacial till, lacustrine sands and clays, and outwash deposits. Beneath these glacial deposits, the bedrock is largely composed of Ordovician and Silurian dolomites. A significant bedrock feature of this Section is the Niagara Escarpment, which runs north to south from the eastern shore of Lake Winnebago to west of Milwaukee. This escarpment is a prominent ridge of resistant Silurian dolomites that which extends from western New York State in an arc through Lakes Huron and Michigan (Dott and Attig 2004:236-237). Poor quality Silurian chert is occasionally found in these outcrops, as well as in secondary deposits along shorelines. Ordovician aged galena and prairie du chien cherts also are found in the underlying bedrock, but are more often deeply buried under glacial till and rarely outcrop at the surface.

The *Laurentian Mixed Forest* province, also known as the Lake Forest, stretches from the western Great Lakes across southeastern Canada and finally reaching the lower reaches of the St. Lawrence River and the Atlantic coast in New Brunswick and eastern Maine. It forms a transitional habitat between the deciduous forests to the south and the boreal forests of the subarctic to the north. It has characteristics of both, yet its transitional nature makes it a somewhat impoverished habitat for many species. Here, species found in the deciduous forests to the south reach the northernmost point of their range, while species characteristic of the boreal forests to the north reach their southernmost extent (Sutton and Sutton 1988:43-57). Forests are dominated by northern hardwoods such as maple and birch, while more xeric landforms support stands of jack pine and white pine and wetlands often support stands of spruce and fir. Dominant fauna include moose, whitetail deer, black bear, and wolves. There are many similarities with the boreal forest to the north, most notably the numerous lakes, streams, rivers and and wetlands. These features support a number of important fish species, including walleye, northern pike, perch, whitefish and sturgeon (McNab and Avers 1994, Sutton and Sutton 1988).

Climate is continental-humid (McNab and Avers 1994) to cool-lacustrine depending on location. The Great Lakes control much of the climate near their shores, and can cause slightly warmer conditions in winter and cooler conditions in summer. The frost free season varies from 80 days in the north to 155 days in the southern reaches of this Province. Precipitation ranges from 26 to 36 inches, and lake effect snowfall can be extreme. Portions of the area can receive from 70 to 400 inches of snow per year, most notably in the Lake Superior snowbelt along the southern shore and extending up the Keweenaw Peninsula.

Within the study region, the Laurentian Mixed Forest Province can be further divided in the *Southern Superior Uplands* and the *Northern Great Lakes* Sections. A small portion of the *Western Superior Section* is present in the extreme western edge of the region.

The Southern Superior Uplands Section is located in north central Wisconsin and the western Upper Peninsula of Michigan. The Southern Superior Uplands is part of the Canadian Shield, a region of Precambrian bedrock that stretches from Wisconsin northward across Hudson

Bay (Dott and Attig 2004:35). Archean age gneiss, and the slightly more recent volcanic basalts resulting from the Penokean mountain building event and the development of the Lake Superior Rift underlie much of this area. While the Precambrian and volcanic nature of the underlying bedrock largely precludes the formation of cherts, quartz is plentiful and was used widely by prehistoric occupants. Another economically important resource, native copper, also resulted from the volcanism and formation of the Lake Superior Rift during the Precambrian. Hot solutions percolated through cooling lavas that form today's basalts along the edges of the Lake Superior rift (Dott and Attig 2004:44-50). These solutions deposited minerals such as silica and metallic copper. Copper is most notably present along the edges of the rift along the Keweenaw Peninsula in Michigan and Isle Royale and Michipicoten Island in northern Lake Superior (Figure 3.4) (Martin 1999; Rapp et al. 2000) .

Today much of this bedrock geology lies beneath glacial moraines, drumlins, eskers, and lacustrine deposits that formed during the Pleistocene and early Holocene glaciation of the region. Bedrock outcrops occur along the Penokee Range in northern Wisconsin, and the Gogebic Range, Porcupine Mountains, and Keweenaw Highlands of the western Upper Peninsula in Michigan. These are the remains of mountain ranges that formed during the period of Precambrian volcanism and the formation of the Lake Superior Rift. They feature moderate to high local relief and elevations of up to 1980 feet amsl (McNab and Avers 1994).

The remainder of the South Superior Uplands consists of level to gently rolling glacial moraines, lacustrine deposits, outwash plains, and other glacial and proglacial landforms. Up to 150 meters of glacial till covers the bedrock, and supports forests of maple and birch on mesic landforms, white pine and jack pine on sandy outwash plains and lacustrine landforms, aspen on areas disturbed by wind and wildfire, and stands of spruce and fir on wetlands (McNab and

Avers 1994). Wetlands, lakes, streams and rivers are common on this immature landscape. Interior rivers are low gradient streams, while those flowing north to Lake Superior often have a much higher gradient with multiple waterfalls as they cross through the highland ranges and over the faults that form the edge of the rift basin. Large terrestrial species include moose, whitetail deer, black bear and wolves. Woodland caribou once occupied these forests, but were extirpated by the early twentieth century. Though large game species are present in the South Superior Uplands, they tend to be solitary browsers or reside in small herds. Dense concentrations of

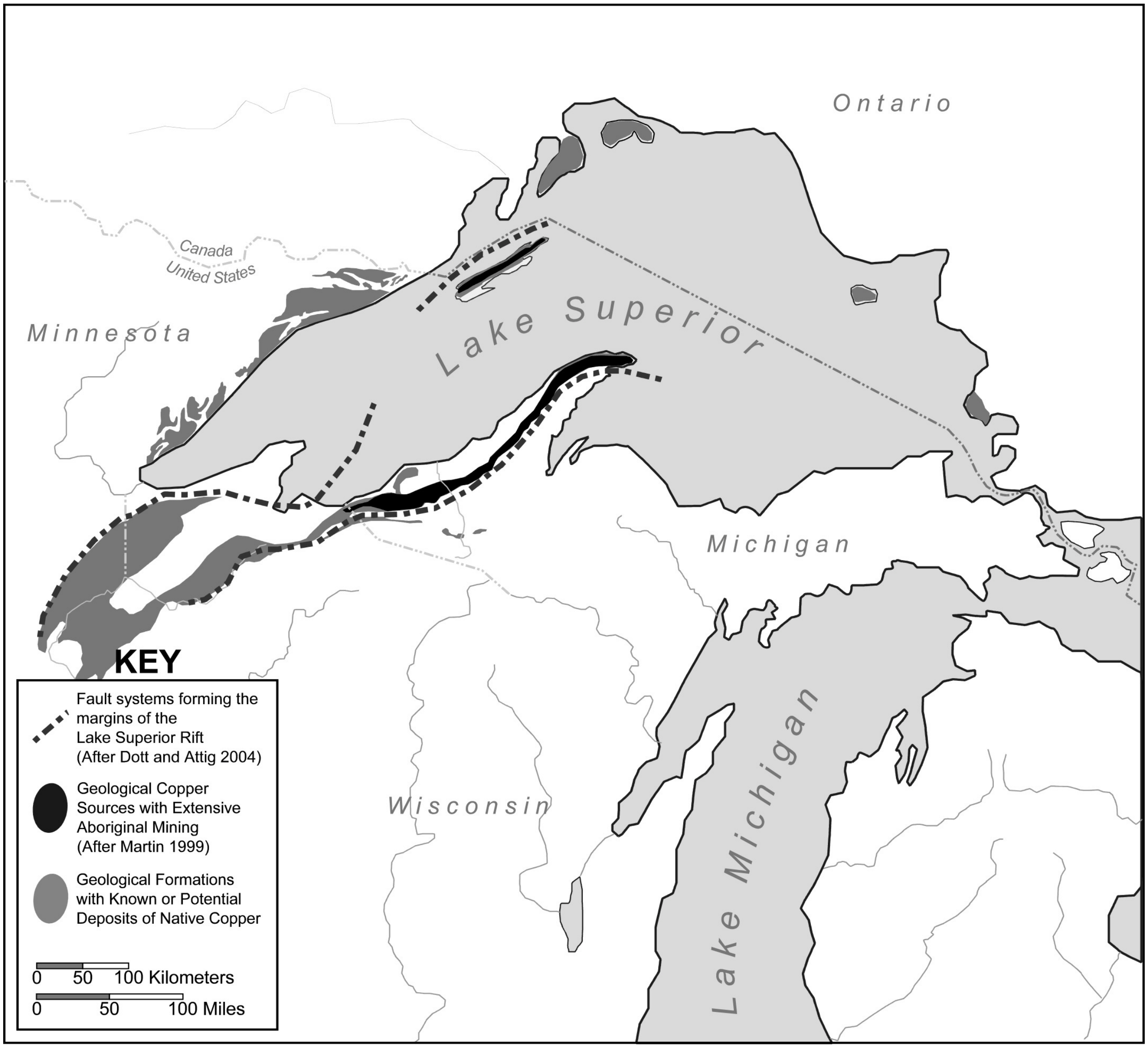


Figure 3.4. Primary sources of native copper in the Lake Superior region.

large terrestrial game species are rare—especially prior to the widespread logging of the late nineteenth and early twentieth centuries which created habitat for greatly expanded whitetail deer herds. Fish species, on the other hand, are plentiful—especially during spawning seasons for such important species as walleye, whitefish, and sturgeon.

The climate of this section is classified as humid-continental (inland) and maritime-continental (along Lake Superior shore), but winter conditions can be quite severe. Winter cold is moderated somewhat by the Great Lakes, with an average January temperature of 9º F, yet lake effect snowfall can be extreme. Annual snowfall ranges from 60 inches to 400 inches, with the most snowfall occurring along the south shore of Lake Superior in the western Upper Peninsula and along the Keweenaw Peninsula.

The Northern Great Lakes Section is a level to gently rolling lowland with lacustrine plains, moraines, and outwash plains. Like the South Superior Uplands, this is a young landscape, but drainage patterns are more established. As a result, lakes and wetlands are less common than in the highlands to the west.

Glacial till up to 300 meters thick overlies the Ordovician and Silurian age dolomites, shales and sandstones that form the bedrock. While this bedrock contains chert bearing formations—including the Galena and Prairie du Chien dolomites—they are deeply buried by more recent glacial deposits. While outcrops of these Ordovician deposits are quite rare, Silurian deposits do outcrop along the Niagara Escarpment that runs down the length of the Door Peninsula and to the east of Lake Winnebago (Dott and Attig 2004), exposing poor quality cherts, such as Silurian chert and Maquoketa chert.

This glacial landscape supports forests of northern hardwoods and conifers. Hardwoods, including maple and birch, dominate the moraines and hills, while jack and white pine occupy sandy outwash and lacustrine soils (McNab and Avers 1994). Conifers such as fir and spruce are typically found in low-lying wetlands. These forests, like those of the Southern Superior Uplands, rarely supported large populations of gregarious ungulates prior to large scale logging of the late nineteenth and early twentieth century. However, whitetail deer and black bear are common occupants of the Northern Great Lakes Section. Fish species include trout, walleye, northern pike and sturgeon.

The climate of this region is classified as cool-lacustrine, and temperature extremes are moderated by the Great Lakes. Winter snowfall can be extreme, but is less than in portions of the Southern Superior Section, and ranges from 70 to 250 inches.

Late Pleistocene Glacial History

Massive continental glaciers plowed across this region during the Pleistocene, drastically modifying the landscape, creating landforms, and moving raw materials including copper and cherts to create secondary sources for these resources that were later utilized by Archaic populations. During the late Pleistocene Wisconsinan glaciation (ca. 100,000 to 10,000 BP), six glacial lobes advanced across the region from northeast to southwest, including the large Superior lobe which filled the Lake Superior basin, and the Lake Michigan and Green Bay lobes that advanced down the Lake Michigan basin (Dott and Attig 2004; Mickelson and Colgan 2004). The smaller Chippewa, Wisconsin Valley, and Langlade lobes advanced across the Upper Peninsula and into northern Wisconsin, but were slowed by rough terrain and bedrock outcrops and did not advance as far. The southwest portion of the area thus remained ice free during the late Pleistocene, leading to the rugged dissected landscape of the Driftless region today. The majority of the project area, however, was sculpted and shaped by the advance and retreat of these six glacial lobes.

Perhaps most importantly for this project, each of these lobes crossed different bedrock outcrops as they advanced, and deposited the rocks and sediment they picked up in different portions of the landscape. As a result, the lithic and copper materials available in secondary glacial sources originated from different provenances. In particular, copper from the Keweenaw Peninsula was carried to the Northern Highlands region and deposited in the moraines of the Chippewa, Wisconsin Valley, and Langlade lobes. Copper resources found in glacial till in the area around Green Bay originated in part from different bedrock sources.

The Archaic Great Lakes

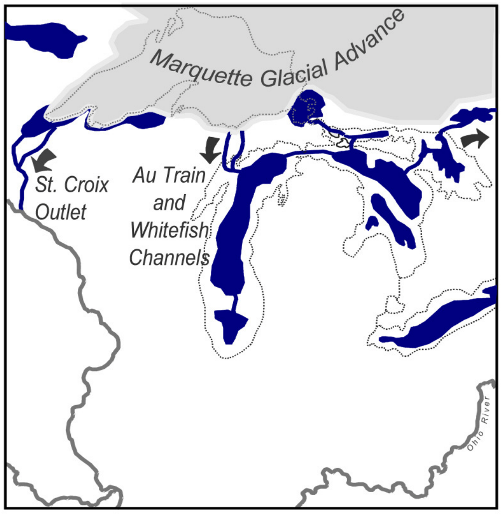
After the glacial retreat, the early to mid Holocene Great Lakes varied considerably in size and drainage. Environmental conditions varied from boreal forests to open parklands and prairies as the climate fluctuated throughout much of the early to mid Holocene. An understanding of the later stages of these fluctuations is important to understanding the changing resources available to Archaic period inhabitants of the region.

Climatic and environmental changes have been profound since the early Holocene. As ice sheets retreated, the zones of coniferous (northern) and deciduous forests also moved northward. Forests did not move as monolithic communities, instead each individual species responded to conditions independently, thus spruce first appears on the recently deglaciated landscape long before other species, while species such as basswood are even today still migrating westward through the Great Lakes.

At the onset of the Early Archaic around 9,900 BP, glaciers still dominated the Lake Superior basin. The Marquette Advance filled much of modern Lake Superior with ice, forming proglacial lakes Duluth and Ontonagon in the southwestern basin, and Lake Minong in the extreme eastern basin.

A period of generally warmer than modern conditions follows the retreat of glacial ice. The Early Archaic roughly corresponds to a period of warmer and drier conditions, while the Middle Archaic in the region is approximately contemporary with a period of warm moist conditions in the upper Great Lakes (Kapp 1999). By the late Middle Archaic, conditions were cooling and approximate modern climate and environmental zones were becoming established (Cleland 1966:23-36; Kapp 1999). The culturally important ecotone between the Eastern Broadleaf forest biotic to the south, and the Laurentian Mixed forest to the north began to stabilize in its modern location of northern Wisconsin, central Minnesota, and northern Michigan, by the Late Archaic of around (Cleland 1966).

Perhaps one of the most profound environmental changes in the region of interest relates to changing lake levels in the western Great Lakes, which affected not only available shoreline but groundwater levels, river flows, and the nature of inland lakes as well. By around 11,000 BP the Superior lobe of the Laurentian Ice Sheet began to retreat out of the Lake Superior basin (Farrand and Drexler 1985; Hansel et al. 1985; Larsen 1985a, 1985b, 1999). As it wasted northeastward, meltwater pooled along its southern margin forming a series of proglacial lakes that eventually merged to form the Duluth Stage of Lake Superior by around 10,700 BP. Lake levels were several hundred feet higher at this time, flooding the eastern Upper Peninsula and merging lakes Superior, Michigan, and Huron into one body of water.



EARLY ARCHAIC

Date: ca. 9900 BP

Comments: At the beginning of the Early Archaic, the Marquette glacial advance fills much of the Lake Superior Basin. Proglacial lakes Ontonagon and Duluth drain down the St. Croix valley into the Mississippi. The Chippewa and Stanley levels in the Michigan and Huron basins drain eastward through the North Bay channel to the Ottawa Valley. The lower lakes (Erie and Ontario) do not directly connect to the early stages of the upper lakes.

Outlets: *St. Croix Valley* (proglacial lakes Ontonagon and Duluth)
North Bay (Lake Michigan and Lake Huron basins)
Au Train and Whitefish Channels (meltwater from Marquette Ice sheet to the Lake Michigan basin)

MIDDLE ARCHAIC

Date: ca. 4500 BP

Comments: By the Middle Archaic, lake levels had risen to their highest point, and lakes Superior, Michigan, and Huron formed a single lake at an elevation of 183 meters (*6.5 meters above modern Lake Michigan levels*). Drainage occurred through three channels: the Chicago outlet to the Mississippi, the North Bay outlet to the Ottawa, and the Port Huron outlet to the lower Great Lakes and St. Lawrence River. Three distinct high water levels occurred at 4500 BP 4000 BP, and 3200 BP (early Late Archaic) corresponding to the Nipissing I, Nipissing II, and Algoma stages. These appear to relate to differential runoff in the drainage basins.

Outlets: C*hicago* (established 6300 BP, closed 4000 BP)
Port Huron (established 6100 BP)
North Bay (established 10,300 BP, closed 4000 BP)

LATE ARCHAIC - EARLY WOODLAND

Date: ca.2500 BP

Comments: By the Late Archaic, isostatic rebound raised the North Bay outlet (ca 4500-4000) and Chicago outlet (4000 BP) above water levels, closing them off as drainage outlets for the Upper Great Lakes. Port Huron remained as the sole outlet. Downcutting of the Port Huron outlet dropped lake levels after the Algoma high water stage of 3200 BP. As a result, Lake Superior separated from lakes Michigan and Huron around 2000 BP, draining to this lower basin through the St. Maries River. The modern Great Lakes are established at this time.

Outlets: *Port Huron* sole outlet for Upper Great Lakes

References:

Farrand and Drexler 1985
Hansel et al. 1985
Larsen 1985a, 1985b, 1999

Figure 3.5. Great Lakes levels and drainage patterns from the Early Archaic to the Early Woodland.

However, the ice readvanced into the Superior basin between 9800 and 9700 BP (Figure 3.5). This Marquette advance filled most of the basin, except for a small area in the southeast known as Lake Minong. The Marquette advance was quite shortlived and retreated northward between 9700 and 9500 BP. As it did so it formed Lake Houghton in the western Superior Basin. At first Lake Houghton drained south through the Brule and St. Croix river valleys to the Mississippi River, but as the Marquette ice sheet retreated, drainage moved eastward first across the central Upper Peninsula into Lake Michigan, then by 9500 BP down the St. Maries outlet into Lake Huron. From 9500 BP until today, Lake Superior has continued to use the St. Maries River as its outlet.

After establishing the St. Maries outlet, water levels dropped dramatically in the Superior Basin to around 420’ amsl (180 feet lower than today). However, isostatic rebound was slowly raising the North Bay channel through which lakes Superior, Michigan, and Huron were drained. This slowly raised the water level from 420 feet around 9500 BP, to above modern levels at 620’ in all three upper lakes during the Nipissing Transgression of around 4700 BP. At this time, the Great Lakes drained through three outlets—one through Chicago into the Mississippi River, the North Bay channel across Ontario in the the St. Lawrence, and the Port Huron channel into the Detroit River and thence to Lake Erie. Differential isostatic rebound eventually closed off the North Bay and Chicago outlets, leaving the modern Great Lakes by approximately 200 BC.

Lithic Resources

Lithic resources were important to Archaic populations as the raw material for tools and as exchange materials. An understanding of the geological sources of these resources is a critical

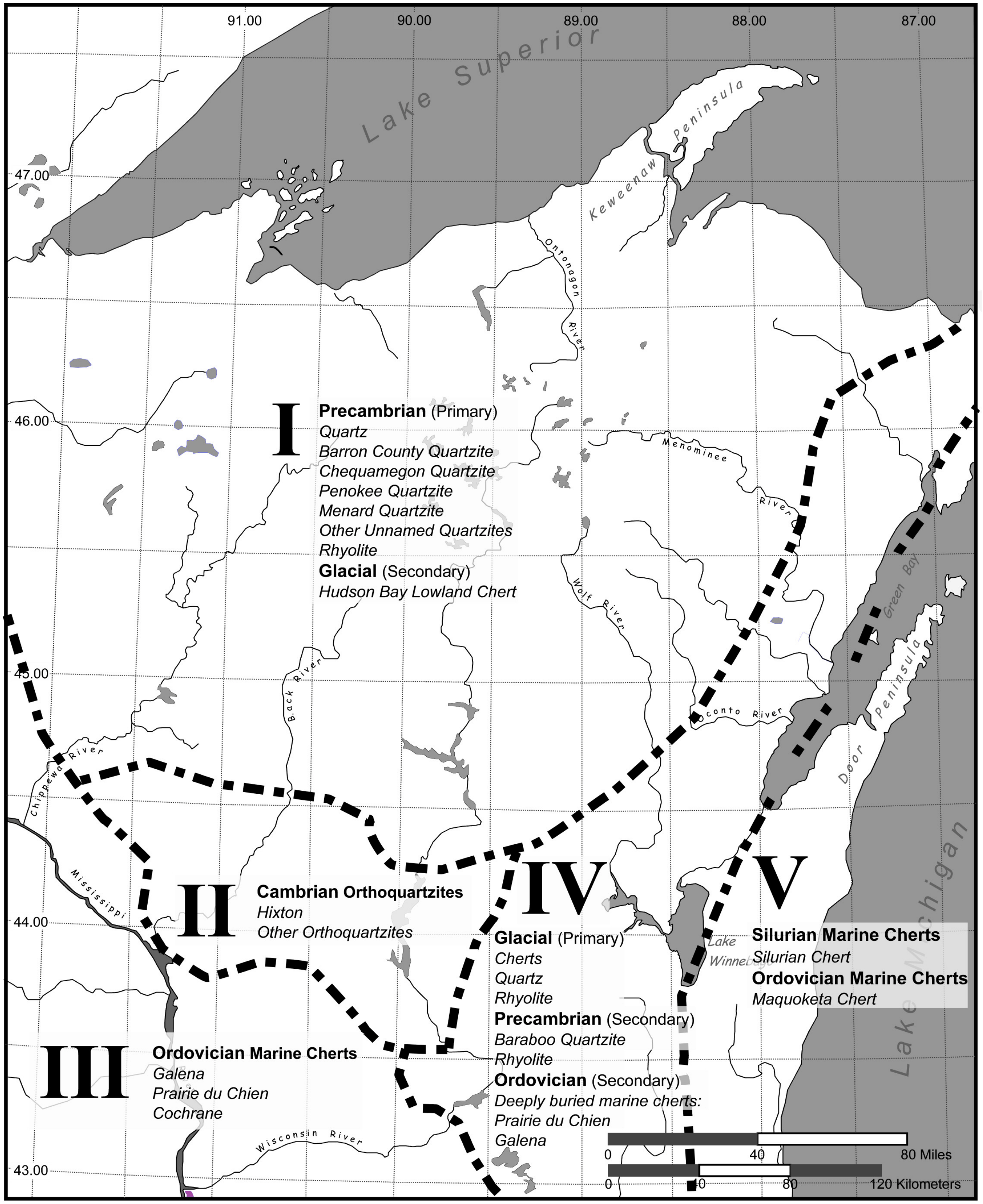


Figure 3.6. Lithic resource zones in the western Great Lakes

foundation upon which our analysis of exchange and mobility will build in later chapters. The lithic resources available within the region are the result of a long history of geological processes—from the formation of the Achaean continental crust, Precambrian mountain building, the shallow Ordovician and Silurian seas, and the more recent Pleistocene glaciations. To clarify the distribution of the various types of lithic materials, the study area can be divided into five zones based on the dominant and available resources (Figure 3.6). The lithic resources themselves comprise four categories: 1) Precambrian quartzites, rhyolites, and quartz; 2) Cambrian orthoquartzites; 3) Ordovician and Silurian marine cherts; and 4) glacially transported lithics including Hudson's Bay Lowland chert, among others.

The northern and central portion of the region (Figure 3.6 "I") occupy the southern-most portion of the Canadian Shield—a region of Precambrian continental crust that includes some of the oldest rocks on Earth. High quality lithic resources of this area are rare, more common materials are small and of generally poor quality. Local materials consist of quartz (visually indistinct from source to source), several types of named and unnamed quartzites, and rhyolite. Other lithic materials, including Hudson's Bay Lowland chert, have been glacially transported in the form of small nodules, and are often found in the glacial till.

Quartz is the most commonly encountered lithic material on archaeological sites of much of this northern region (e.g., Hill 1994; Salzer 1974; Van Dyke 1985; Winkler and Blodgett n.d.). Veins of this material outcrop throughout much of the western Upper Peninsula and northern and eastern Wisconsin. Quartz is also found as cobbles of various sizes in streambeds, lakeshores, and glacial landforms. Though quartz is difficult to work and resulting tools are often expedient or thick formal tools, both forms were extensively utilized prehistorically in the northern part of the study area (e.g., Hill 1994; Van Dyke 1985).

Though quartz is the most commonly used material in northern Late Archaic sites, other resources are available in Zone I, including basalt, rhyolite, quartzite, and glacially deposited nodules of Hudson Bay Lowland chert. Igneous basalt forms the bedrock underlying the northern portion of the area. It outcrops along the Penokee, Gogebic, and Keweenaw highlands south of Lake Superior, and is also commonly found as glacially deposited boulders and cobbles in glacial landforms, streambeds, and shorelines. Fine grained basalt is often found as tools and debitage, though never in large quantities, in northern Archaic sites.

Rhyolite is occasionally found in outcrops and as secondary deposits of boulders and cobbles from the central to the northern portion of the study area (Behm 1997; Winkler and Blodgett n.d.). Rhyolite is an igneous and often porphyritic rock (Andrefsky 1998:46-48) and in the study area it is often characterized by small phenocrysts in a dark grayish aphanitic matrix (Winkler and Blodgett n.d.). Rhyolite was most frequently used in tool production during the Paleoindian and Early Archaic periods (Winkler and Blodgett n.d.:76), though it was occasionally used in later times.

Several poorly defined and undefined quartzites occur in Zone I, including Chequamegon, Penokee, and Barron County, Rib Mountain, Powers Bluff, and Black River Falls quartzites. Other quartzites are found in the northeast in the highlands around Marquette, Michigan. Quartzites are formed from sandstones that have been metamorphosed by heat and pressure, causing the sand grains to recrystalize and fuse and resulting in the conchoidal fracture properties needed for tool production (Andrefsky 1998:54-56). All of these quartzites are Precambrian in age, and occur as outcrops in areas of bedrock exposure as well as boulders and cobbles in secondary contexts throughout Zone I (Dott 1983; Winkler and Blodgett n.d.).

The only known chert resource in Zone I is Hudson Bay Lowland (HBL) chert. The geological source of this material is not well known; it appears to have been glacially transported from a source north of Lake Superior and redeposited in secondary contexts as small cobbles and pebbles. These are often found in streambeds and shorelines in the northern part of the study area. Some have argued that HBL chert is actually more than one material, but other authorities argue that this is a valid category (Bakken 1997:60). HBL chert is an extremely high quality chert, and doubtless would have been more frequently utilized if it occurred in larger cobbles. However, it typically occurs in small pebbles and cobbles which limits its utility. It seems to have been used whenever possible, and Archaic peoples often used bipolar techniques to flake even the smallest cobble.

Zone II, located in west-central Wisconsin, is characterized by the presence of several orthoquartzites—the most well known of which is Hixton Silicified Sandstone (Boszhardt 1998; Porter 1961). These materials formed as Cambrian sandstones that were later covered by Ordovician limestone. Groundwater percolating through these formations carried dissolved silica into the Cambrian aged sandstones, where it reconstituted to cement the sand grains into a silica matrix with conchoidal fracture properties (Andrefsky 1998; Boszhard 1998; Winkler and Blodgett n.d.) The Ordovician limestone subsequently eroded away, exposing the orthoquartzites on ridges and higher bluffs throughout the northern Driftless Region. These orthoquartzites are distinguished from the northern quartzites not only by color, but by the presence of the undeformed sand grains cemented in the silica matrix.

Until recently, Hixton Silicified Sandstone was thought to be the only orthoquartzite from this region that had been regularly used by prehistoric populations (Boszhardt 1998). Recently, though, additional sources of other named and unnamed orthoquartzites have been documented in Zone II, including Alma, Arcadia Ridge, Browns Valley, King Bluff, and a growing list of other sources (Boszhardt 1998; Broihahn and Moebius 1992; Penman 1981). It seems that several orthoquartzite sources are present an area north of La Crosse.

Elsewhere, the Ordovician limestones and dolomites remained exposed in stream valleys and bluffs along the Mississippi River and its tributaries in southwest Wisconsin, southeast Minnesota, and northwest Iowa. This region is referred to as Zone III in this study, and contains some of the most readily available and extensively used cherts in the region—Prairie du Chien and Galena. Prairie du Chien cherts are lower Ordovician in age, and occur in two chert bearing formations of the Prairie du Chien Group—the Oneota and Shakopee formations (Bakken 1997; Morrow 1994). In northeast Iowa, cherts of these two formations are defined as Shakopee and Oneota cherts (Morrow 1994), but in Wisconsin and Minnesota these two formations and their cherts are often not distinguishable and the two are subsumed under the name Prairie du Chien (PDC) chert (Bakken 1997). PDC occurs in beds and nodules in dolomite outcrops, or as residual cherts in the soils and streambeds of the southwestern portion of the study area. This material can be of high quality, but is frequently cracked and fractured as a result of weathering. Heat treating improves its quality, and appears to have been frequently practiced during the Archaic (Boszhardt 1998). Visually, PDC is often distinctive with its typically light grey to cream color, though very light colored pieces can be confused with Burlington chert from the middle Mississippi Valley (Bakken 1997; Morrow 1994). Unlike Burlington, Oneota formation PDC often exhibits a marbled appearance, while cherts from the Shakopee formation are typically oolitic. PDC cherts are the only light colored oolitic cherts in the study area. A natural orange color is more common in the eastern sources (Winkler and Blodgett n.d.).

Galena chert is another widespread Ordovician chert characteristic of Zone III. Galena occurs as nodules within dolomite formations of the Galena Group, and is found throughout southeastern Wisconsin, northeastern Iowa, southeastern Minnesota, and far northern Illinois (Bakken 1997:61-62). Like PDC, Galena is often found in outcrops and as residual chert nodules in soils and along streambeds. This chert is often a light to darker grey, occasionally with a brown cast to it, is fairly opaque and somewhat chalky, and contains distinctive fossil fragments and fossilized worm casts or borings. Also like PDC, Galena was widely available and extensively used by Archaic populations.

The more recently identified Cochrane chert was less widely available, and is localized in its distribution to uplands in the area around La Crosse, Wisconsin (Boszhardt 1998; Winkler and Blodgett n.d.). This is an iron enriched chert, similar to Root River and Cedar Valley cherts in adjacent portions of Minnesota, which occurs as residual nodules and slabs in upland clays (Boszhardt 1998:94-96; Bakken 1997; Winkler and Blodgett n.d.). Cochrane is often dark brown, black, tan, or white in color, and lacks fossil inclusions (Winkler and Blodgett n.d.). In Wisconsin, this chert is often laminated and waxy, while the Minnesota versions occur as either opaque or translucent good quality cherts (Boszhardt 1998; Bakken 1997). Use of this material by Archaic populations within the study area was limited (Winkler and Blodgett n.d.).

Zone IV is a region of mixed lithic resources, including deeply buried Galena and Prairie du Chien formations; glacially deposited cherts, quartz, and basalt; and localized outcrops of rhyolite and Baraboo quartzite. Many of the same resources that originate in Zones I and III may also be available here due to glacial redeposition of northern resources, and potential bedrock exposures and residual deposits of Ordovician cherts. In particular, the Ordovician Shakopee, Oneota, and Galena Group formations which contain PDC and Galena cherts occur beneath thick glacial till deposits and sandy outwash plains. While outcrops of these cherts are not well known in Zone IV, some potential for their presence exists in deeper stream valleys, as well as for the presence of limited quantities of residual cherts in the soils and streambeds.

Primary deposits of two lithic resources are documented in Zone IV; Baraboo quartzite and rhyolite. Baraboo quartzite is a hard, maroon colored Precambrian metaquartzite that outcrops around Devils Lake in south-central Wisconsin (Dott 1983; Winkler and Blodgett n.d.). Baraboo quartzite occurs in thick outcrops, cliffs, and as boulders, slabs and nodules. This is a very hard material, and does not appear to have been widely used as a lithic material by Archaic populations in the region.

Marquette rhyolite outcrops in the Fox River basin of south-central Wisconsin, west of Lake Winnebago. This material occurs as large boulders to smaller cobbles, and was an important lithic resource during the Late Paleoindian and Early Archaic periods (Behm 1991, 1997). Marquette rhyolite was seldom used after this period, and is rarely found north of Lake Winnebago.

The limestone and dolomite outcrops of the Niagara Escarpment are the characteristic feature of Zone V (Dott and Attig 2004:236-237). Silurian chert occurs within the Alexandrian series of this dolomite escarpment, and is also found as residual deposits in the soils, streambeds, and shorelines of eastern Wisconsin (Winkler and Blodgett n.d.: 24-25). Similar cherts in Illinois and eastern Iowa are known as Blanding and Kankakee cherts (Morrow 1994). This chert is typically light grey in color, with a medium texture, chalky luster, and occasionally a few small fossil crinoids and corals. This material was widely used in the area within which it is found, but was less utilized outside of Zone V.

Maquoketa chert, also known as Silurian 2, is an Upper Ordovician chert found within the Maquoketa formation at its juncture with the overlying Silurian dolomites of the Niagara Escarpment. In Wisconsin, Maquoketa is an olive green to grey material with medium to medium fine texture and a dull luster (Winkler and Blodgett n.d.). Fossils or inclusions are typically absent, but some banding or streaking may be visible. Known outcrops of Maquoketa in Wisconsin are confined to the Door Peninsula, but this chert may also occur in northern Illinois and southeastern Minnesota (Bakken 1997:63).

Several non-regional lithics were important resources in Archaic exchange and interaction within the western Great Lakes, including Knife River flint from the upper Missouri River basin, Burlington chert from the middle Mississippi Valley, Wyandotte chert from the Ohio Valley, and Onondaga chert from the Lake Ontario basin. Jasper Taconite and Knife Lake siltstone from the Rainey River region of the north shore of Lake Superior are also occasionally found in Archaic components south of Lake Superior (Figure 3.7).

Knife River Flint (KRF) is often found in small quantities, and primarily as small proximal flakes, on Archaic sites of the region (e.g., Hill 2006, Chapter Seven this volume). This is a distinctive, high quality, brown translucent flint formed from silicified peat deposits and is found as residual chert in the Golden Valley formation of western North Dakota (Ahler 1986; Clayton et al. 1970). Its presence on Late Archaic sites in the upper Great Lakes has often been disputed, with some authorities arguing that HBL chert, or other local glacially deposited silicates, was being misidentified as KRF. However, INAA analysis of samples from the Duck Lake site has positively identified KRF and established that previous identifications of this material may also be correct (Bury 1997; Hill 2006). The distinctive color and translucency, internal peaty structure, and bluish white patina of KRF are positive indicators and are not found

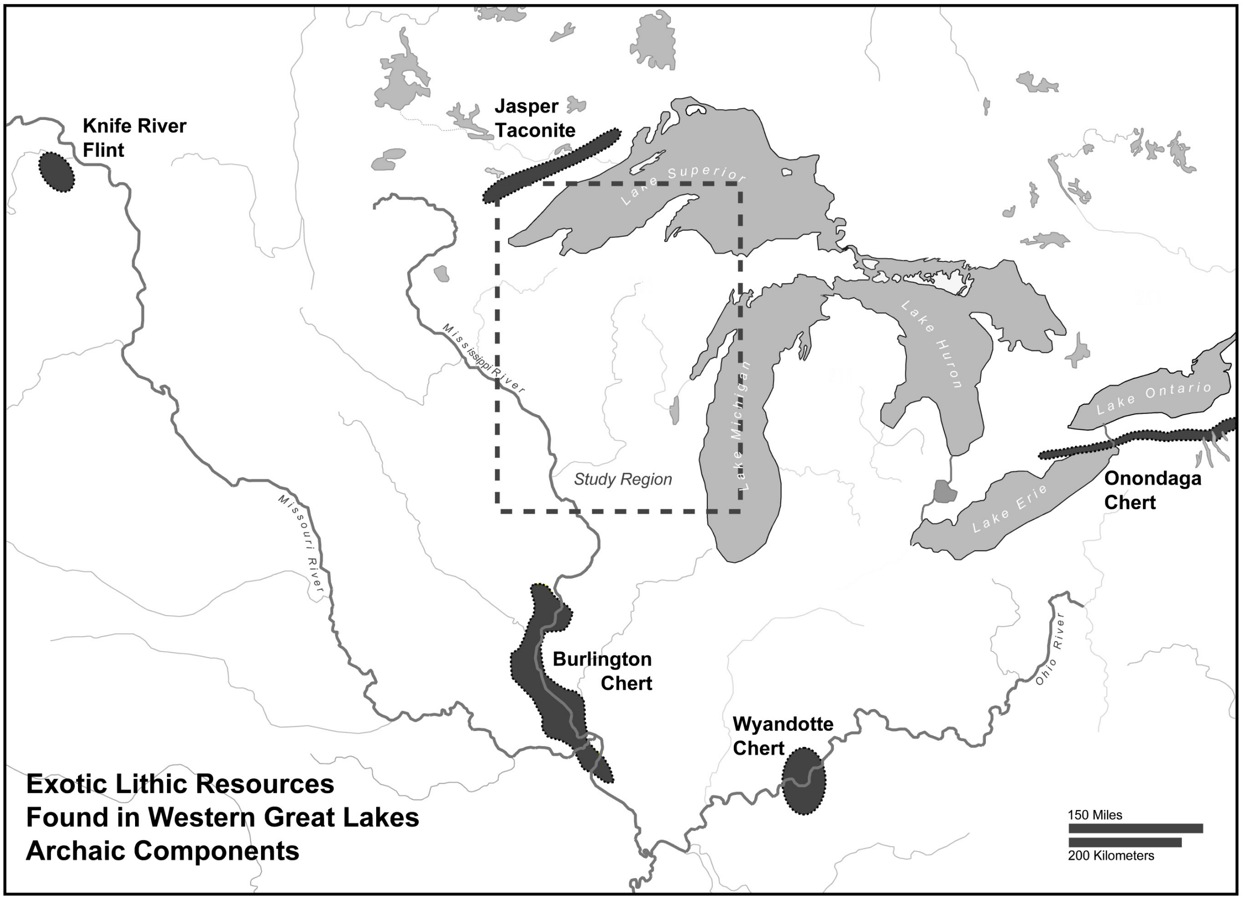


Figure 3.7. Source areas for lithic resources that occur outside the western Great Lakes study area, but that are often found in Late Archaic components.

in combination on other lithics of the region.

Burlington chert is a high quality, fine textured, and light colored chert from the Mississippian-aged Burlington Limestone formation found along the Mississippi Valley from southeastern Iowa to east central Missouri and southern Illinois. The material is typically white to light gray, though heat treatment often leaves a pinkish to reddish cast and a lustrous texture (Bakken 1997; Morrow 1984). It can occasionally resemble light colored non-oolitic PDC, but can often be distinguished microscopically. Burlington is not often found as debitage in Late Archaic components of the Great Lakes, but more often in the form of large hafted and unhafted bifaces from cache and mortuary contexts.

Onondaga chert is an eastern Great Lakes chert of Devonian age that is found as nodules and residual cherts along the Onondaga Escarpment (Hammer 1976; Wray 1948). This escarpment is sporadically found north of Lake Erie from Windsor, Ontario to Niagara Falls where it enters New York, crosses New York from west to east, across the Finger Lakes region and to the Hudson Valley, where it turns south and extends into Pennsylvania. The material is a high quality, dark gray to bluish gray, fine textured chert with a waxy luster, and was often used for tool production in the eastern Great Lakes. Some color variation has been noted, with Ontario specimens often exhibiting a mottled blue-brown or tan appearance, specimens from around Niagara Falls are often dark blue-gray to black, western New York pieces again exhibit the mottled blue-brown to tan coloring, central New York specimens are often medium gray, and eastern New York cherts are more often lighter blue in color (Wray 1948:41) While the material is distinctive, its presence in Late Archaic components of the western Great Lakes was suspect until INAA analysis of materials found at Duck Lake definitively identified this material (Bury 1997; Hill 2006, Chapter Seven this volume).

Lithics from the North Shore of Lake Superior are not commonly found in Late Archaic components south of the lake, but are occasionally present. Most common among these is Knife Lake Siltstone, a fine grained and dark colored argillite from northeast and east central Minnesota (Bakken 1997). Similar argillites are also commonly found in eastern Minnesota, and they may be considered a regional lithic resource found in the extreme eastern and northern portions of Zone I. A second North Shore lithic material is quite rare south of the lake; this material is variously known as Jasper Taconite, jaspilite, or oolitic jasper. Jasper Taconite is a distinctive cranberry red, Precambrian jasper with numerous small round oolites. It is a very fine grained and good quality material, whose primary source appears to be in the formations of the

Animikie Group in the Rainey River region of extreme northeastern Minnesota and adjacent Ontario (Bakken 1997; Julig et al. 1989).

Perhaps the most important non-local lithic material to this study is Wyandotte chert. Wyandotte is a bluish gray, fine grained, and high quality Upper Mississippian aged chert with a satiny luster and frequent concentric banding. This chert is found as nodules in outcrops, residual deposits, and caves in the Ohio Valley of southern Indiana and north central Kentucky. It was used in the Ohio Valley in all time periods, but its use dramatically increased during the Terminal Archaic to Middle Woodland period when it was used to produce large bifaces and Turkey Tail points that were subsequently exchanged throughout much of the midcontinent (Didier 1967; Krakker 1997; Moore 2008). Mining of Wyandotte chert in deep cave sites, such as Wyandotte Cave, began during the Middle Archaic and continued through to Woodland periods in southern Indiana (Munson and Munson 1990). Large formal bifaces and Turkey Tail points manufactured from Wyandotte chert are one of the key traits used by Ritzenthaler and Quimby (1962) in their definition of the Red Ocher culture in the Upper Great Lakes, a cultural complex that will be discussed further in the following chapter.

CHAPTER FOUR

ARCHAIC CULTURAL CONTEXT OF THE WESTERN GREAT LAKES

The landscape of rivers, lakes, and forests described in the previous chapter was populated by communities of foragers during the period archaeologists refer to as the "Archaic." In the western Great Lakes, the later part of the Archaic from 4000 and 2000 years ago sees the development of increasingly elaborate systems of exchange, mortuary ritual, and social complexity. In this chapter we will come to know these people through a review of the Archaic culture history of the region and an examination of some of the sites and complexes that represent their communities and cemeteries. Along the way, we will encounter some of the materials that are featured in their growing systems of exchange, including copper beads and large bifaces of Wyandotte and Burlington chert. We will also look at some of the social changes that previous research has noted during this period, and we will also attempt to determine where populations were concentrated so that we may better understand the locations of communities that were participating or avoiding exchange networks during this period.

The "Archaic" of North America is one of several examples of Mesolithic and Epipaleolithic adaptations throughout the world. These are generally characterized by small-scale societies (small population bands or tribes organized around kinship and egalitarian principles) temporally positioned between the dispersed large game hunters of the Upper Paleolithic and the increasingly nucleated farming settlements of the Neolithic (Adams 1991; Bar-Yosef 1989; Chang 1986; Jochim 2002; Kujit and Goring-Morris 2002). Economies exploited a wide variety of resources available during the early Holocene, including small game, fish and other aquatic resources, and plants. In many areas of the world, trade appears, cemeteries and social distinctions become evident, and social complexity increases (Jochim 2002). Territoriality and regional differentiation are often more pronounced during this period as people adapt to local environments and the variety of resources available therein (Funk 1978:19).

"Archaic" was first used in a taxonomic sense by Ritchie (1932), who applied it to the Lamoka Culture in New York. Since then, this taxon has referred to a temporal period, a tradition, a cultural stage (Willey and Phillips 1958), a subsistence pattern, and even a type of technology (Caldwell 1958; Fitting 1975; Griffin 1952; Stoltman 1986). Here, "Archaic" is used to denote a tradition, where characteristics of material culture, subsistence, settlement, and other cultural aspects define a specific way of life. In this sense, the Archaic of the study region may be defined by three basic criteria (Stoltman 1986:207): 1) subsistence based on hunting a diverse array of large and small game and the gathering of wild plant resources' 2) absence of ceramics; and 3) burial of dead in natural knolls or other features, not in constructed burial mounds.

The Archaic tradition debuts throughout North America during the early Holocene around 10,000 BP, as populations increase and adapt to local post-glacial conditions (Fitting 1975:65; Funk 1978:19-20; Stoltman 1986:209). While Paleoindians depended on large game species, the subsequent Archaic populations relied on a broader array of locally available faunal and floral resources, heralding a significant shift in adaptation. White-tailed deer, caribou, elk, and many smaller game animals, plants, and aquatic resources became economically important in varying degrees (Funk 1978).

The appearance of ceramics and constructed burial mounds around 2000 BP is widely cited as marking the end of the Archaic in the study region (Bozhardt et al. 1986:243; Stoltman 1986:227). The intervening 8000 years were quite dynamic as populations increase, the environment approximates modern conditions, territoriality and regional diversity appear, formal cemeteries are developed, positions of social status are evidenced in the form of mortuary remains accompanied by exotic lithic, copper and shell artifacts, and monumental construction begin in some regions (Funk 1978; Saunders et al. 2005). Thus the Archaic, and in particular the dynamic Late Archaic, is an ideal setting in which to study the processes associated with developing interaction and the formation of larger and more complex social institutions.

Archaic Culture History

The eight thousand year span of the Archaic tradition is usually divided into early, middle, and late periods (Fowler 1959; Funk 1978; Stoltman 1997). The Early Archaic (ca. 10,000-5000 BP) begins with the advent of the warmer climatic regime and lower lake levels noted at the beginning of Holocene in Chapter Three. Forests rapidly covered the landscape as glaciers retreated at the end of the Pleistocene, and the study area was characterized by coniferous forests throughout much of the early Holocene (Cleland 1966; Kapp 1999:50-55).

In eastern North America, sites of the Early Archaic are generally more numerous, larger, and richer in material culture than are earlier Paleoindian sites, suggesting larger populations and a more reliable resource base (Funk 1978:19). However, Early Archaic sites are quite rare in the study region (William Lovis, personal communication 2006; Stoltman 1997). In northern Wisconsin, Salzer (1974:45-46) tentatively identified the Squirrel River phase as Early Archaic based in part on similarities to the Itasca Bison Kill site in northern Minnesota (Shay 1971). At the Deadman Slough site on the Flambeau River of northern Wisconsin, Meinholz and Kuehn (1996) identified a late Paleoindian/Early Archaic occupation in which the occupants utilized white-tailed deer and turtle for subsistence. Farther east, Buckmaster has identified a series of sites in the north-central Upper Peninsula of Michigan that she tentatively identifies as Late

Paleoindian/Early Archaic (Buckmaster and Paquette 1988). In southeastern Wisconsin, the Bass site represents an Early Archaic quarry and workshop associated with Hardin Barbed projectile points (Stoltman 1986:211-217). The Samel's Field site is a Late Paleoindian/Early Archaic site in northern lower Michigan (Cleland and Ruggles 1996). Reconstructions of human occupation in the western Great Lakes during the Early Archaic feature small bands of mobile foragers with low population densities exploiting a wide variety of plant and animal resources (Shott 1999:79-82). Some have suggested that population densities of Early Archaic foragers may even have been lower than earlier Paleoindian hunters.

Populations increased by the Middle Archaic (ca. 5000-3700 BP). Environmental conditions were somewhat warmer and drier, but modern environmental conditions had not yet been achieved (Kapp 1999:54-57). As the region experienced differential isostatic rebound, the upper Great Lakes drained through a variety of outlets with significant effects on lake levels, finally achieving their highest levels during the Nipissing Transgression around 4700 BP (see Figure 3.5).

A number of Middle Archaic sites are known throughout the study region, both reflecting increases in population and in site visibility. One of the most widely known cultural manifestations of the Middle Archaic has been referred to as the Old Copper Complex, which represents a number of related societies throughout the upper Great Lakes that shared a similar copper technology and burial ceremonialism. Native copper from the Lake Superior basin was used for a variety of tools, including socketed and tanged projectile points and knives, socketed axes, and awls (Ritzenthaler 1957; Stoltman 1986:217-226; Martin 1999; Martin and Pleger 1999). In southeastern Wisconsin, several rockshelters were also first utilized during this period (Stoltman 1997). Cemeteries appear as well, often featuring extended interments, bundle burials and cremations with occasional copper and lithic grave goods. Though population densities have increased and copper tools and formal cemeteries appear, Middle Archaic groups are still mobile foraging societies. Investigations of Middle Archaic cemeteries, such as Oconto in northeastern Wisconsin, have lent strong support to the interpretation that these societies were largely egalitarian with little differentiation or display of acquired status (Pleger 2000).

The Late Archaic (ca. 3700–2000 BP) begins in parallel with a shift in climate and environment to modern conditions (Robertson et al. 1999). Prior to 3000 years ago, the climate of the western Great Lakes became slightly moister and cooler (Kapp 1999). The mixed coniferous-northern hardwood forests of the Laurentian Mixed Forest were established in the north and the oak-hickory-savannah habitats of the Eastern Broadleaf Forest occupied the south, with the boundary between the two traversing northern Wisconsin and the northern lower peninsula of Michigan (Cleland 1966). Lake levels of the Great Lakes stabilized following the Nipissing and Algoma high water stages of approximately 4500, 4000, and 3200 BP. (Farrand and Drexler 1985; Larsen 1985, 1999:28; Sassaman 2005; see also Lovis et al. 2005).

While the Late Archaic is roughly coincident with the establishment of modern environmental conditions, it is a time of significant social change. Populations continued to increase and the number of sites reflects both this increased population and improved site preservation. The frequency of radiocarbon dates from the region (Figure 4.1) clearly demonstrates a significant increase in the number of excavated and dated components beginning at this time. Formal cemeteries, first seen in the Middle Archaic, become more elaborate and grave goods indicate an increasing importance of social display and differentiation of status (Pleger 2000). Exchange systems are also elaborated, and materials from the Gulf Coast, northern Great Plains, Rocky Mountains, Ohio Valley, and eastern Great Lakes all appear in domestic and mortuary sites (Hill 2005, this volume; Morrow et al. 1992; Pleger 2000). Adaptation to modern environmental conditions is suggested by the increasing importance of fishing, the use of more diverse resources, the establishment of corporate groups, and possibly tribal level social organization and formal territories (Bender 1985; Cleland 1966; Pleger 2000; Robertson et al. 1999). Several researchers see the roots of subsequent Middle Woodland exchange and social systems in the emerging complexity of the Late Archaic (e.g., Bender 1985; Braun and Plog 1982; Krakker 1997; Sassaman 2005)

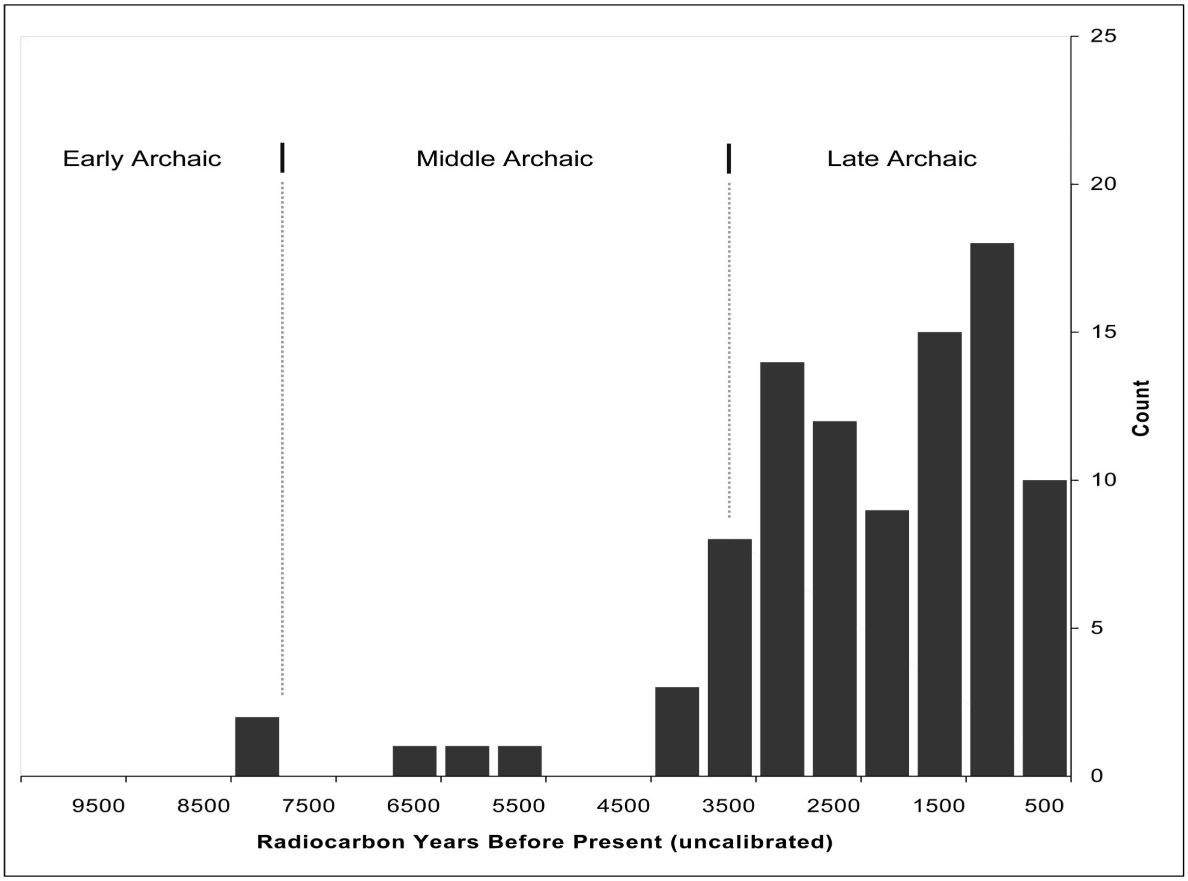


Figure 4.1. Frequency of radiocarbon dates from northern Wisconsin and western Upper Michigan. While many factors affect the frequency of dates, they are associated with the number and visibility of components from various times in the past. In this case, note the significant increase in dates after 4000 BP, potentially indicating increased occupations or populations in the area.

Archaic Phases: 4000 to 2000 B.P.

Several Archaic cultural complexes have been defined within the region between 4000 and 2000 BP (Figures 4.2 and 4.3). These include the Middle Archaic phases associated with the Old Copper Complex that occupy much of the region during the early part of this time period, the Preston Phase and subsequent Durst Phase in the Driftless Area in the Mississippi River basin, the Burnt Rollways Phase in the Northern Highlands, and the Late Archaic phases associated with the Redo Ocher complex which are principally located in the Lake Michigan basin during the latter half of the period (See Figure 4.4 for the location of sites discussed in the following text).

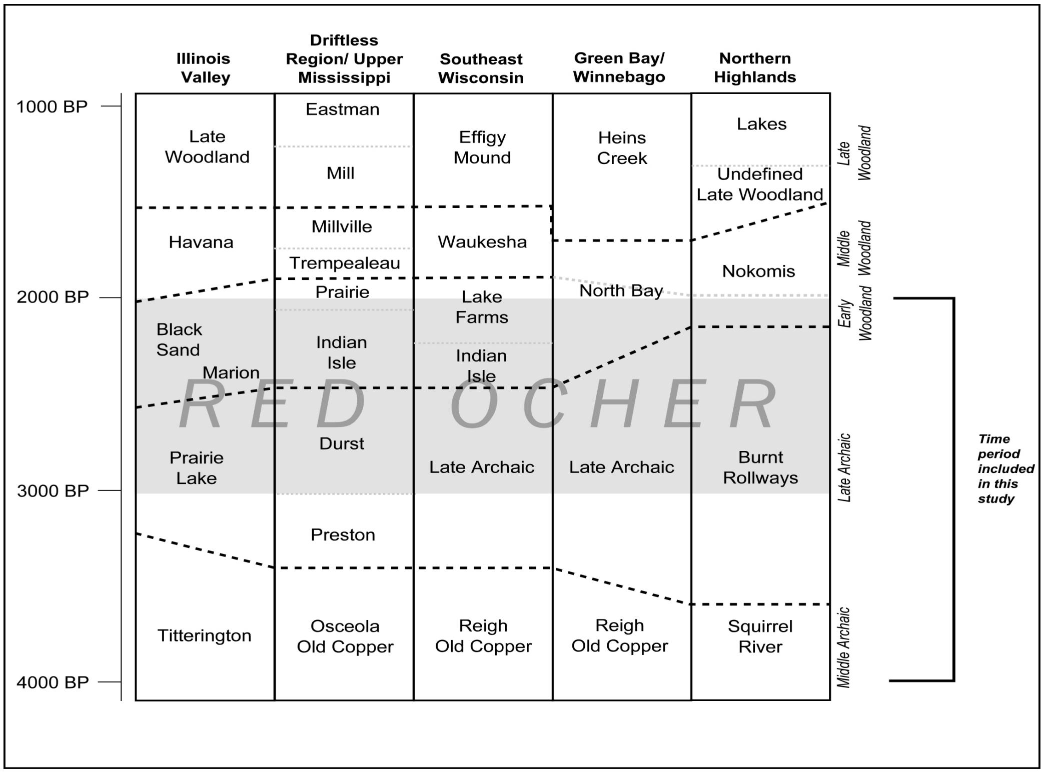


Figure 4.2. Comparison of the cultural chronologies from the Driftless Region, Southeastern Wisconsin, the Green Bay-Lake Winnebago region, and the Northern Highlands of northern Wisconsin and upper Michigan. The cultural chronology of the Illinois Valley is included for comparative purposes.

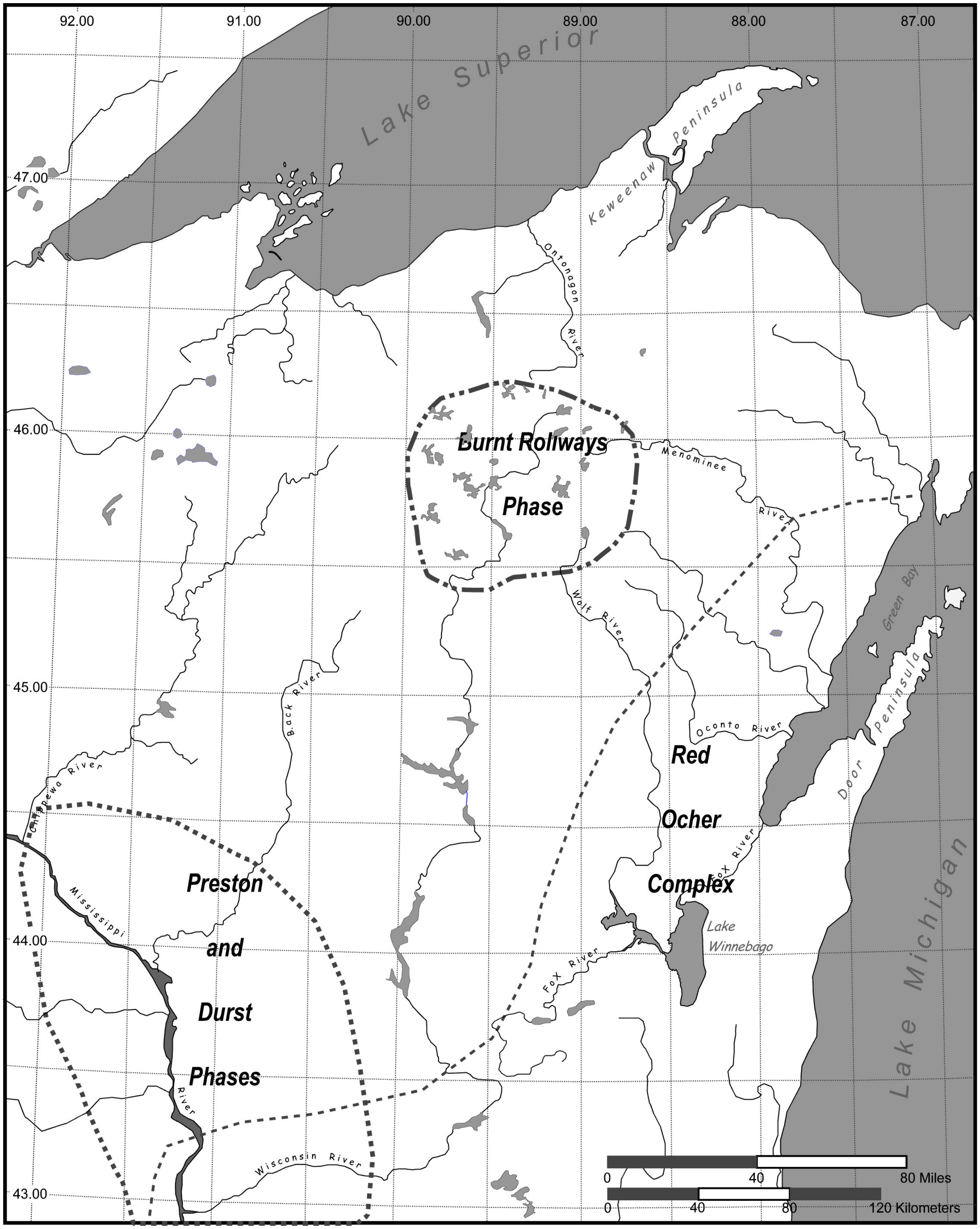


Figure 4.3. Named contemporary Late Archaic phases and complexes in the study area.

Middle Archaic

The Middle Archaic of the study area is best known through cemeteries at the Oconto, Reigh, Price III, and Osceola sites. These sites were initially used to define the Old Copper Complex, but today are more appropriately viewed as representing three phases of perhaps two different Archaic traditions (Stoltman 1997:131).

Copper artifacts such as socketed and tanged projectile points, knives, crescents, beads, and awls had been found throughout northeastern North America since at least the nineteenth century. The focus of their distribution seemed to be in Wisconsin, and McKern (1942) estimated that this industry was of great antiquity based upon the degree of corrosion evident on the copper and the presence of copper in stratigraphic context elsewhere in the Northeast. Given the numbers of copper artifacts found in Wisconsin, it is somewhat surprising that their association with definable cultural contexts did not occur until 1945 when they were found at the Osceola site along the Mississippi River in southwestern Wisconsin (Ritzenthaler 1946).

The Old Copper complex was then defined based on the investigations at Osceola and subsequent excavations at the Oconto site near the western shore of Green Bay in northeastern Wisconsin (Ritzenthaler and Scholz 1946; Ritzenthaler and Wittry 1952; Wittry and Ritzenthaler 1956). Shortly thereafter, two additional cemetery sites were added to the collection of Old Copper type sites; these include the Price III site on the lower Wisconsin River and the Reigh site near Lake Winnebago (Figure 4.4).

While these four sites define this complex, there are clear differences between sites in southwestern Wisconsin and those in the northeast that suggest important social and cultural differences. Recognizing that “Old Copper” is a concept that obscures our understanding of these multiple societies, Stoltman (1997:131) laid the foundation for new archaeological

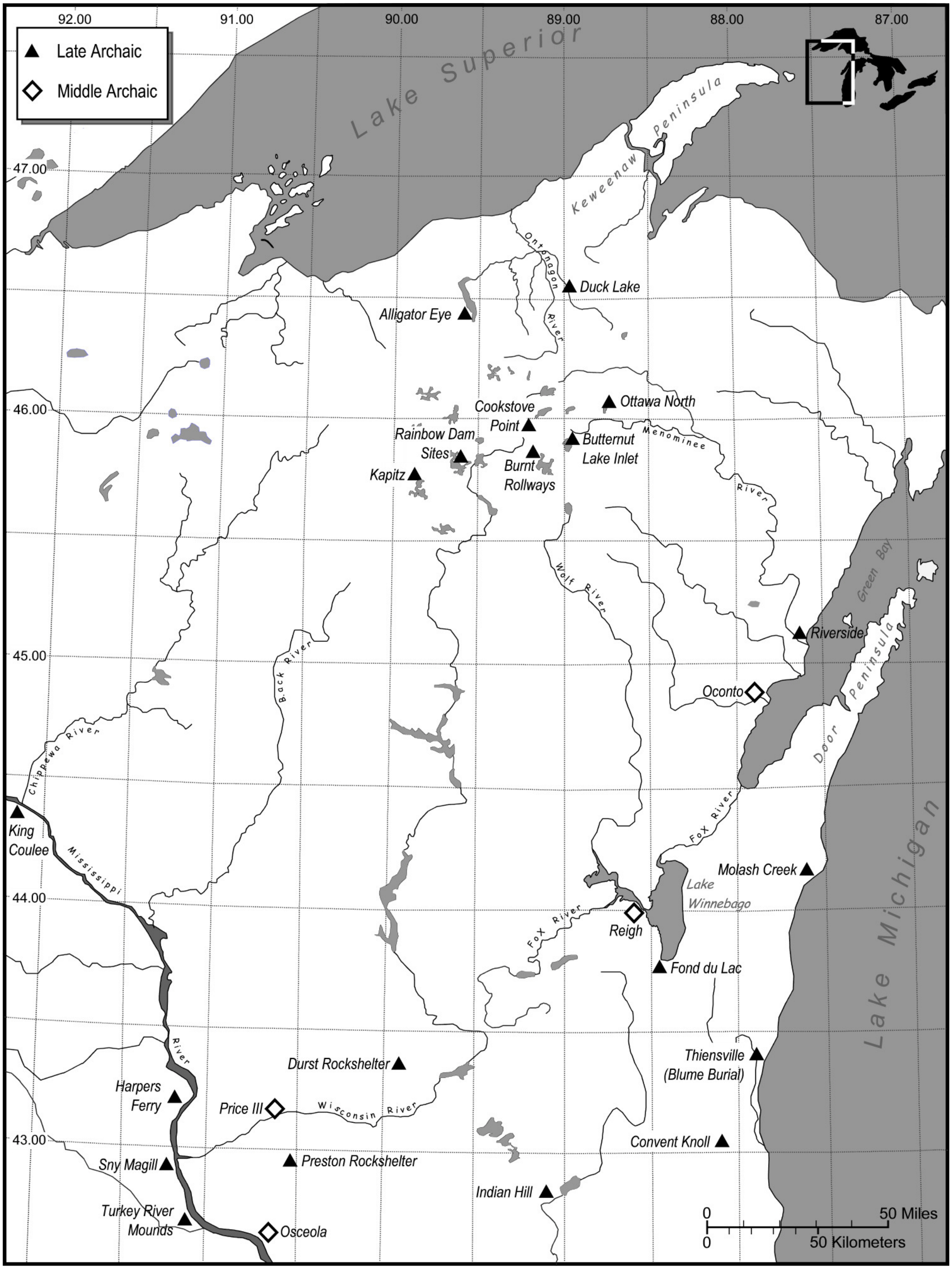


Figure 4.4. The location of sites discussed in the text.

systematics by naming three Middle Archaic phases—the Osceola phase in the Mississippi Valley and the Oconto and Reigh phases in the area around Green Bay and Lake Winnebago. The Osceola phase consists of the Osceola and Price III sites in southeastern Wisconsin and is characterized by secondary interment, mass graves, the presence of grave goods not associated with individuals, and the occurrence of Raddatz and Osceola projectile points. The Osceola phase is found in the Driftless Area of the lower Wisconsin and nearby Mississippi River valleys.

To the northeast, the Oconto and Reigh phases represent sequential phases of an Archaic tradition that occupies the Lake Winnebago and Green Bay region. This tradition features cemeteries in which primary burial is the predominant form of interment, with the use of multiple and discrete graves, the placement of grave goods with specific individuals, and Reigh type bifaces. Several dates from Oconto and Reigh, including new dates analyzed as part of this research, indicate that the Old Copper Complex is a Middle Archaic to late Middle Archaic phenomenon in the region (Table 4.1), spanning the period from 7500 to around 3000 BP (Stoltman 1997).

The diversity in these Middle Archaic sites supports the conclusion that the Old Copper Complex is not a uniform cultural tradition. Rather, it seems to be a phenomenon in which multiple societies share the use of distinctive copper artifacts while differing in other aspects such as mortuary customs and subsistence. In the study area, the Middle Archaic appears to be represented by at least two different populations—one occupying the Lake Michigan basin in the northeast, the other focused around the Driftless Region and Mississippi Valley in the southwest. Both of these appear to represent egalitarian societies featuring achieved status. Exotic materials are rare and appear to be limited to only a few individuals—in particular at the Oconto and Reigh sites—perhaps indicative of this achieved status. Based on the scarcity of these exotic materials, exchange and interaction with others seems to be rare and sporadic. However, violence does appear for the first time in the region in the form of a projectile point embedded in a human vertebra at the Price III site (Freeman 1966).

Table 4.1. Uncalibrated and Calibrated Radiocarbon Dates from the Middle Archaic Oconto and Reigh Sites

Site	Lab No.	Uncal BP	Cal 1σ BP	Prob.	References
Oconto	C837/C839[*]	7510 ± 600	7726-9015	1.000	Wittry and Ritzenthaler 1956
Oconto	AA19678/WG2404	6020 ± 60	6790-6942	1.000	Pleger 2000
Oconto	C836	5600 ± 600	5744-7028	0.969	Wittry and Ritzenthaler 1956
			7056-7068	0.007	
			7112-7115	0.025	
Oconto	AA20281/WG2413	5250 ± 110	5917-6129	0.841	Pleger 2000
			6139-6181	0.159	
Oconto	GAK	4540 ± 400	4626-4763	0.098	Ritzenthaler 1970; Steinbring 1975
			4789-5656	0.902	
Reigh	Beta247459[†]	4490 ± 40	5048-5083	0.190	Hill (this volume)
			5102-5139	0.197	
			5161-5199	0.211	
			5211-5283	0.402	
Reigh	M644	3660 ± 250	3689-4299	0.932	Crane and Griffin 1959
			4326-5354	0.033	
			4369-4389	0.023	
			4391-4402	0.012	

Calibrated using CALIB 5.0.2 and the intcal04 curve

[*] *dates thought to be in error*

[†] *New dates processed as part of this research*

Late Archaic

The Late Archaic is represented by several named and unnamed phases in the study area. In the southwest, the Preston Phase and the somewhat later Durst Phase are found in the Driftless Area and the Mississippi Valley. Around the western shores of Lake Michigan are sites representing Late Archaic populations that are participating in the Red Ocher interaction complex. In the Northern Highlands, the Burnt Rollways phase is contemporary with Preston, Durst, and the Lake Michigan communities.

Driftless Area and Mississippi Valley. The early Late Archaic of southwestern Wisconsin is represented by the Preston Phase, named after the Preston Rockshelter in Grant County (Figure 4.4). This site was excavated by the University of Wisconsin between 1966 and 1969, but the results have never been published and the Preston Phase was not defined until the 1990s (Stoltman 1997:134).

The Preston phase is marked by the appearance rockshelter components containing small corner-notched to side-notched points referred to as Preston Notched. Similar points are found throughout the Midcontinent, especially to the south where they are associated with the more thoroughly defined Riverton culture of the Ohio and Wabash valleys in southern Illinois and Indiana (Winters 1969). In Illinois, Riverton is well dated to the period between 3450 to 2950 BP, while only a single uncalibrated radiocarbon date of 2780 ± 65 BP (calibrated to 2953-2793 BP using the intcal04 curve) has been produced for the Preston phase (Stoltman 1997:134).

While this phase was not identified until recently, a review of previously excavated sites suggests that Preston components are also present at other rockshelters in the Driftless Region of southwestern Wisconsin. In most cases, these reveal Preston notched points in strata directly below components containing Durst points, representing the Durst phase. Durst points are similar in size to Preston, but have more rounded shoulders and narrower bases. In Wisconsin, the Durst phase has been dated to the period between 3040 and 2570 BP, perhaps lasting a few centuries later in some areas (Stoltman 1997:134-137).

The hallmark Durst point also has stylistic similarities outside the region. Unlike Preston, however, Durst's similarities lie to the east across the lower Great Lakes to New York and southern New England. Justice (1987:127-130) has included Durst, along with lower Michigan's Dustin point, in the Lamoka Cluster, demonstrating potential relationships between the Lamoka phase in New York (Ritchie 1969), Dustin components in Michigan (Halsey 1999; Robertson et al. 1999), and the Durst phase in Wisconsin. In New York, Lamoka phase sites date somewhat earlier than Durst phase components in Wisconsin, with reliable dates ranging between 5450 and 3750 BP (Justice 1987:129).

The first domesticated plants appear in the region during this period. The Late Archaic King Coulee site is found in the Driftless Region of Minnesota directly across the Mississippi River from Wisconsin (Figure 4.4). Excavations here have identified the first appearance of domesticated squash (*Cucurbita pepo*), seeds of which have been AMS dated to 2530 ± 60 BP (Perkl 1998). Associated with these seeds was a component featuring the use of freshwater mussels, walnut and butternut seeds, and non-diagnostic lithics.

Northern Highlands. Farther north at the headwaters of the Wisconsin River, Salzer (1969, 1974) identified several sites of the Burnt Rollways Phase. Originally defined based on excavations at the Burnt Rollways site on the Eagle River and the Kapitz site on the Willow River, recent research has expanded the phase to include components in northern Wisconsin at sites such as Cookstove Point, Rainbow Dam East, Rainbow Dam West, and Butternut Lake Inlet (Bruhy et al. 1999; Moffat and Speth 1999; Salzer 1974). Similar components are found at the Ottawa North, Alligator Eye, and Duck Lake sites in the adjacent portions of upper Michigan (Hill 1994, 2006). At this time it seems appropriate to suggest that the Michigan sites demonstrate that this Late Archaic phase has a diffuse and limited extension into the highlands of the western Upper Peninsula, and thus occupy much of the Northern Highlands region including the headwaters of the Wisconsin, Wolf, Menominee, and Ontonagon rivers (Figure 4.4).

These sites typically consist of a large but diffuse scatter of cultural material and few features; for example, the Burnt Rollways site occupies and area of approximately 15 acres, while the Duck Lake site exceeds 20 acres in size. Some degree of internal patterning is present, and the sites likely represent multiple seasonal occupations. Features are often limited to a few simple hearths, although the Butternut Lake Inlet site features a house floor and acorn roasting pit (Bruhy et al. 1999). Other components are much smaller and more specialized, such as the quartz quarry represented at the Alligator Eye site and the short term field camp at the Ottawa North site (Hill 1994).

This phase is characterized by projectile points similar to those of the Preston and Durst phases, often made from non-local cherts. As shown in Chapter Three, high quality cryptocrystalline materials are scarce in the Northern Highlands, and the majority of debitage and expedient tools associated with this phase consist of locally available quartz. However, formal tools are often manufactured from non-local cherts including lithics from Driftless Region and Lake Michigan basin in combination with limited frequencies of more distant materials such as Onondaga chert from Lake Ontario and Knife River Flint from the Upper Missouri River (Hill 1994, 2006; Moffat and Speth 1999; Salzer 1969:344). Burnt Rollways also features a well developed copper industry, with copper awls, crescents, knives, points, and beads often found in association with the debris from copper tool/ornament production (Hill 2006; Moffat and Speth 1999; Salzer 1969).

When first defined, no radiocarbon dates were available for the Burnt Rollways phase. Salzer (1969:346-348) relied upon noted similarities in lithic and copper technology to the Middle Archaic components at Reigh and Oconto, the Red Ocher component at Riverside, and the Riverton Culture of the Wabash Valley far to the south, to estimate the dates of this phase falling between 2950 and 2450 BP. Subsequent excavation and dating of components at the Rainbow Dam sites (Moffat and Speth 1999), Alligator Eye and Ottawa North (Hill 1994), Duck

Lake (Hill 2006), and dating of charcoal excavated by Salzer from the Burnt Rollways site (Hill, this volume) have extended that range to between 3640 and 2280 uncalibrated years B.P. (Table 4.2)

The range of dates shows that the Burnt Rollways phase is contemporary with the Preston and Durst phases in the Driftless Region, the end of the Middle Archaic Reigh phase in the Lake Michigan basin, and much of the later Late Archaic Riverside site occupation discussed below. This phase then spans the period between the end of the Middle Archaic Reigh phase to the elaborate mortuary systems of the Late Archaic and Early Woodland represented at the Riverside site

Lake Michigan. Several Late Archaic sites are located along the eastern portion of the study area, near the western shore of Lake Michigan and Green Bay, including cemeteries at the Riverside, Thiensville, Convent Knoll, Molash Creek, and Fond du Lac sites (Figure 4.4). These represent local populations that appear to be engaged in a regional system of interaction, ritual, and exchange known as the Red Ocher complex. While they participate in this larger interaction network, they also appear to represent local populations with antecedents in the Middle Archaic. In particular, the burial represented in Riverside Feature 6 is an early interment (uncalibrated 3040 ± 150 BP) that strongly resembles the mortuary practices of the Middle Archaic Reigh cemetery (Papworth 1967), suggesting local continuity from this earlier population.

Few of these sites have been dated, with the notable exception of Riverside, with 17 radiocarbon dates spanning the period from 3040 ± 150 BP to 1300 ±200 BP (uncalibrated). The most recent date is thought to be associated with a later occupation, and the Late Archaic use of the site occurred between 3040 and 1949 BP (Table 4.3).

Table 4.2. Uncalibrated and calibrated radiocarbon dates for the Burnt Rollways phase.

Site	**Lab No.**	**Uncal BP**	**Cal 1σ BP**	**Prob.**	**References**
Alligator Eye	Beta-	3640 ± 150	3723-3797	0.135	Hill 1994
			3816-4154	0.855	
			4209-4216	0.010	
	Beta-	3490 ± 110	3618-3623	0.011	Hill 1994
			3629-3904	0.989	
Rainbow Dam East	WIS2269	3630 ± 60	3863-3992	0.830	Moffat and Speth 1999
			4040-4073	0.170	
Duck Lake	Beta099777	3420 ± 50	3588-3602	0.072	Hill 2006
			3610-3722	0.846	
			3798-3814	0.082	
Duck Lake	Beta124454	3400 ± 110	3485-3526	0.121	Hill 2006
			3554-3731	0.685	
			3745-3772	0.081	
			3790-3826	0.112	
Ottawa North	Beta42451	3320 ± 220	3272-3283	0.013	Hill 1994
			3330-3863	0.987	
Rainbow Dam West	WIS2270	3270 ± 80	3402-3577	1.000	Moffat and Speth 1999
Butternut Lake F4H	Beta122682	2990 ± 70	3075-3265	0.910	Bruhy et al. 1999
			3295-3319	0.090	
Butternut Lake F4G	Beta109472	2780 ± 40	2807-2816	0.062	Bruhy et al. 1999
			2844-2930	0.847	
			2933-2945	0.091	
Butternut Lake F4G	Beta122681	2620 ± 60	2619-2632	0.065	Bruhy et al. 1999
			2707-2796	0.864	
			2824-2842	0.071	
Burnt Rollways	Beta232440	2280 ± 40	2183-2196	0.116	Hill (this volume)
			2205-2233	0.280	
			2306-2347	0.605	
Burnt Rollways	Beta243582*	1540 ± 40	1381-1422	0.415	Hill (this volume)
			1432-1441	0.070	
			1459-1515	0.515	

** thought to be associated with an overlying Woodland component*

The Red Ocher complex consists of communities interacting from the western Lake Michigan basin southward down the Illinois and Mississippi valleys, and eastward into lower Michigan and northwestern Indiana (Ritzenthaler and Quimby 1962). Known only from mortuary sites and caches, it is likely that Red Ocher actually represents a number of interacting local societies rather than a single culture, and may best be thought of as an interaction sphere emphasizing

Table 4.3. Uncalibrated and calibrated radiocarbon dates for the Riverside Site.

Lab No.	Uncal BP	Cal 1σ BP	Probability	References
M-658	3040 ± 150	3005-3015	0.020	Crane and Griffin 1959
		3021-3053	0.064	Pleger 2000
		3058-3391	0.916	
AA19679/WG2405	2960 ± 50	3009-3011	0.004	Pleger 2000
		3038-3048	0.041	
		3062-3217	0.951	
		3234-3236	0.004	
AA19685/WG2411	2850 ± 50	2880-2912	0.200	Pleger 2000
		2918-3006	0.648	
		3013-3033	0.099	
		3051-3060	0.053	
AA19680/WG2406	2790 ± 50	2806-2817	0.066	Pleger 2000
		2844-2956	0.934	
AA19677/WG2403	2780 ± 65	2792-2830	0.221	Pleger 2000
		2838-2952	0.779	
AA19684/WG2410	2710 ± 50	2765-2848	1.000	Pleger 2000
AA19686/WG2412	2690 ± 60	2755-2845	1.000	Pleger 2000
AA19682/WG2408	2605 ± 45	2624-2627	0.023	Pleger 2000
		2714-2771	0.977	
AA19683/WG2409	2605 ± 50	2620-2631	0.078	Pleger 2000
		2709-2779	0.922	
AA20282/WG2414	2495 ± 65	2487-2645	0.713	Pleger 2000
		2650-2719	0.287	
M-1719	2460 ± 140	2363-2422	0.182	Hruska 1967
		2426-2618	0.590	
		2633-2705	0.228	
AA19681/WG2407	2380 ± 50	2342-2472	0.968	Pleger 2000
		2479-2485	0.032	
M-1717	2190 ± 140	2005-2025	0.052	Hruska 1967
		2037-2341	0.948	
M-1718	2080 ± 140	1892-2161	0.832	Hruska 1967
		2168-2178	0.023	
		2243-2301	0.145	
M-1716	2050 ± 130	1869-2156	0.933	Hruska 1967
		2267-2296	0.067	
M-1715	1949 ± 130	1722-2045	1.000	Hruska 1967
M-772*	1300 ± 200	980-1037	0.115	Papworth 1967

** Date not accepted as representing the Red Ocher component*

exchange of goods and shared ritual practices. Today, Red Ocher could be tentatively grouped into at least three distinct geographic subgroups: 1) Western Lake Michigan, including the areas around Green Bay, Lake Winnebago, and the Lake Michigan shoreline south to northern Illinois; 2) Riverine, including the Mississippi and Illinois valleys, along with other regions of central

Illinois and Indiana, and 3) Lower Michigan/Saginaw Valley, including primarily the Saginaw Valley region of the Lake Huron basin and adjacent areas.

Red Ocher was originally defined based on excavations at Mound F^{o}11 at the Morton Mound Group in the central Illinois Valley (Cole and Deuel 1937:58-69). The name "Red Ocher" was bestowed upon this complex as a consequence of the liberal use of powdered hematite in several of the burials in Mound F^{o}11 and the older components of Mound F^{o}14. Cole and Deuel (1937:199-206) tentatively placed Red Ocher in their "Woodland Pattern" based on the presence of a few fragments of thick grit-tempered ceramics, yet clearly distinguished it as earlier than the Hopewellian and later Middle Mississippian patterns which stratigraphically overlaid the Red Ocher deposits. Characteristics of this mortuary complex noted by Cole and Deuel (1937:66, 225) include burial in natural ridges or low constructed mounds, a combination of flexed burials and cremations, and mortuary furniture including turkey tail bifaces, large stemmed bifaces, a variety of shell gorgets, copper beads, copper awls, and a copper "plaque."

Ritzenthaler and Quimby (1962) subsequently expanded the definition of Red Ocher from the Illinois Valley where it was first identified, to include much of the Upper Great Lakes and surrounding regions and noted that it was primarily located in Wisconsin, Michigan, Illinois, Iowa, Indiana, and Ohio. Recognizing the variability inherent in Red Ocher, Ritzenthaler and Quimby defined it as a mortuary complex with a "series of overlapping associations of marginal traits based on a core of nuclear traits that include the following: flexed burials in pits on ridges of sand, gravel, or loess; powdered red ocher in grave; "turkey-tail" blades of chipped blue-gray flint; rather large lanceolate ceremonial knives of whitish flint; and caches of ovate-trianguloid points" (1962:244). They further noted that Early Red Ocher (3450-2450 BP) belonged to the

Late Archaic, while Late Red Ocher (2450-2050 BP) belonged the Early Woodland. (Ritzenthaler and Quimby 1962:256-257).

One of the best known Red Ocher cemeteries is the Riverside Site on the shore of Green Bay in the Upper Peninsula of Michigan (Hruska 1967; Papworth 1967; Pleger 2000). Here, over sixty individuals were interred in a formal cemetery that included a variety of treatments such as primary interment, secondary interment, and cremation. Most individuals were interred with few grave goods, while a few—predominantly women and juveniles—were buried with lavish deposits of copper beads, large numbers of bifaces made from exotic cherts, copper projectile points, and copper celts. In analyzing the Riverside materials, Pleger (1998) contrasted the clear appearance of status distinction in Red Ocher with the egalitarian society represented at the Middle Archaic cemetery located at the nearby Oconto site.

Grave goods at Riverside also indicate interaction with other communities, both neighboring and distant. Copper is prominently featured in Red Ocher sites such as Riverside. Here, hundreds of copper beads, along with copper points, awls, crescents, and celts, were interred with the dead, suggesting access to either copper sources or interaction with other groups with such access. Bifaces of Wyandotte chert from the Ohio Valley of southern Indiana are prominently associated with certain individuals and appear to have been manufactured by specialists in the Ohio Valley for exchange (Didier 1967; Hill 2007; Hruska 1967; Munson and Munson 1990). Marine shell from the Gulf of Mexico has also been found at Riverside (Hruska 1967), as has obsidian from Yellowstone (Pleger 2000) indicating the scale of interaction characteristic of Red Ocher components.

In Wisconsin, few other Red Ocher components have been scientifically excavated, though many have been discovered and unearthed through other means, such as the expansion of sand and gravel quarries. Red Ocher components, typically consisting of burials with powdered hematite, turkey tail bifaces manufactured from Wyandotte chert, large lanceolate bifaces of Burlington chert, ovate bifaces, copper beads, copper awls, and shell beads, are most commonly associated with the eastern portion of the region along Lake Michigan and around Lake Winnebago (Ritzenthaler and Quimby 1962:258-260). Sites such as Thiensville, Fond du Lac, and Molash Creek demonstrate the widespread nature of Red Ocher in the western Lake Michigan basin (Halsey 1972; Ritzenthaler and Niehoff 1958; Ritzenthaler and Quimby 1962). One site that was scientifically excavated is Convent Knoll near Milwaukee (Overstreet 1980). Here, the interments of seven young adult males and one infant strongly suggest the presence of interpersonal violence and warfare in Red Ocher society. One adult male died from wounds and was buried near the infant, perhaps also a victim of violence. Both were interred with elaborate grave goods including large lanceolate bifaces, a well made hafted biface, a copper celt, copper and marine shell beads, and a copper awl. The remaining six young adult males were buried in a mass grave, apparently with little regard for placement and with no deliberate grave goods. These six individuals all died from violent trauma, and several were dismembered (Overstreet 1980). Interpersonal violence appears in other Red Ocher sites, notably at Riverside (Hruska 1967), but Convent Knoll seems to represent a single violent event.

Red Ocher is most commonly associated with the Lake Michigan basin, but Red Ocher components are also found along the Mississippi River in the Driftless Region of Iowa, and along tributaries of the Mississippi such as the Rock River (Hackenberger et al. 1993; Ritzenthaler and Quimby 1962:260-261). In particular, Mound 38 at the Turkey River Mound Group contains significant Red Ocher graves, and other nearby sites including Sny Magill Mound 43 and the Harpers Ferry site also contain Red Ocher components (Green and Shermer n.d.; Ritzenthaler and Quimby 1962). Red Ocher burials are also associated with mound construction at the Indian Hills Mound Group in the Upper Rock River valley (Hackenberger et al. 1993). In the Mississippi Valley, Red Ocher is either associated with the construction of mounds, or possibly underlies later Middle Woodland mound construction. In that regard, Mississippi Valley Red Ocher shares some commonalities with Red Ocher in the Illinois Valley to the south. Red Ocher components in the Lake Michigan basin typically lack deliberate mound construction, instead favoring natural ridges and knolls of sand or gravel for use as cemeteries.

Discussion

As shown above, the western Great Lakes region is home to several archaeologically recognized populations during the period from 4000 to 2000 years ago. In the Driftless Region, the Osceola phase of the Middle Archaic is followed by Late Archaic communities of the Preston phase around 3500 and the later Durst phase communities from 3000 to 2500 years ago. During the Late Archaic, domesticated squash first appear in the Driftless Region at the King Coulee site. Foraging still predominates in the Late Archaic economies of upper Mississippi Valley, but changes are underway in the form of increased interaction with non-local communities and eventually with the introduction of ceramics which mark the beginning of the Early Woodland Indian Isle phase.

To the east in the Lake Michigan basin, the early Middle Archaic Oconto phase communities are followed by the late Middle Archaic Reigh phase communities. The Reigh phase seems to represent the founding population for an in-situ development that is later represented by the Late Archaic Riverside site and other communities that are participating in the Red Ocher interaction network. During the Late Archaic, dispersed foraging populations are participating in exchange and shared forms of ritual with other communities throughout the midcontinent, perhaps following the model proposed in Chapter Two. Ceramic technology appears late in the northern Lake Michigan basin, and the Riverside site spans the transition from Late Archaic to Early Woodland with little significant change other than the addition of thick-walled ceramics.

Contemporary with the late Reigh phase and the subsequent Late Archaic phases of the Driftless Region and the Lake Michigan basin, the communities of the Burnt Rollways phase occupied the Northern Highlands at the headwaters of many of the study areas river systems from 3600 to 2200 years ago. Burnt Rollways populations subsisted on small game and likely fish, along with wild plant resources and nuts. Burnt Rollways populations manufactured copper beads, knives, awls, and points from nearby copper sources, and may have exchanged copper for other items such as non-local lithics for the production of projectile points and bifaces. By 2000 years ago, ceramics also appear in the Northern Highlands, signaling the development of the Early to Middle Woodland Nokomis phase. Nokomis components often overlie earlier Burnt Rollways components at the same sites, and largely represent a continuation of Archaic adaptations with the addition of ceramic technology, greater population density, and perhaps more substantial architecture (Salzer 1969, 1974).

As will be discussed below, these contemporary communities were in place during a time of important change. Increasing regional interaction, the introduction of domesticated plants and ceramics, and changes in social organization, ritual, and status all appear to characterize this as an important period in the development of prehistoric societies in the Midcontinent.

Archaic Social Change

The Archaic of eastern North America, as with Archaic and Mesolithic periods elsewhere, is a period of significant economic and social adaptation to changing environmental conditions and an increasingly crowded and competitive social environment (Jochim 2002:141; Tuck 1978:41; Zvelebil 2005). This period witnesses the development of formal cemeteries, mortuary ritual, far reaching exchange networks, monumental and public architecture, and even the development of domesticated cultigens. These are significant events that serve to signal the major social changes that occur among Archaic societies.

Much of the early development occurs far to the south in the lower Mississippi Valley. Experiments with public architecture, mound building, formal cemeteries, organized communities, cultigens, and long distance trade started much earlier in the lower Mississippi Valley and slowly spread northward during the Late Archaic (Anderson and Sassaman 2004; Bense 1994; Sassaman and Anderson 2004). The first appearance of public architecture is at sites such as Watson Brake site in northeast Louisiana, where construction of an oval arrangement of eleven mounds connected by earthen ridges began by 5450 BP (Saunders et al. 2005). Watson Brake was used as an occupation site where activities appear to have been dominated by secular tasks such as cooking, flintknapping, and bead manufacture.

Long-distance exchange also develops earlier in the southern Mississippi Valley. By 4150 BP, the Poverty Point culture developed in the Mississippi Valley from southern Louisiana to as far north as southeast Missouri and western Kentucky. The Poverty Point site itself is an impressive 500 acre complex consisting of a large 70 foot high main mound, a smaller secondary mound, and a series of concentric ridges arranged in a semicircle (Bense 1994; Ford and Webb 1956). The Poverty Point culture a developed extensive networks to acquire raw materials and distribute finished goods from an industry that produced stone lapidary items such as beads and pendants (Bense 1994:99-104). Materials were acquired from as far away as the Appalachian Mountains, the Atlantic Piedmont, the Rocky Mountains, Illinois, and copper from the Great Lakes.

The appearance of formal cemetery areas has been linked to the presence of corporate lineal inheritance of crucial and restricted resources (Charles and Buikstra 1983:117; Goldstein 1980; Saxe 1970). Goldstein (1980) noted that ritual associated with death is one way in which corporate groups may reaffirm connections to ancestors and legitimize lineal descent of rights and resources. The presence of formal structured areas for the interment of the dead is evidence that corporate groups likely had rights over the use of critical, limited, or spatially bounded resources. Public mortuary ritual is an act that validates membership in corporate groups or recognizes and reaffirms rights to resources and social roles.

In the Midcontinent, cemeteries and limited mortuary ritual appear in the Middle Archaic at sites such as Indian Knoll in Kentucky (Anderson and Sassaman 2004; Webb 1974) and in the western Great Lakes at Oconto and Osceola (Baerreis et al. 1954; Ritzenthaler and Wittry 1952, Stoltman 1997). By the Late Archaic, mortuary ritual appears becomes much more elaborate, and distinctions in status or social position are apparent at sites as far north as Riverside (Hruska 1967; Pleger 2000). Analysis of the Late Archaic mortuary population at Riverside, and comparison with similar populations from earlier Middle Archaic cemeteries, reveals that the Late Archaic features more abundant grave goods, that these grave goods are more often made of exotic materials and are predominantly prestige items (Pleger 2000).

The movement of copper, lithics, shell, and other exotic resources throughout the midcontinent also demonstrates intensification, elaboration, and increasing scale of social interaction beginning during the Late Archaic. In particular, copper and lithics were both featured in intra-regional, inter-regional, and long distance exchange systems; copper from its sources around Lake Superior, and lithics from multiple sources in southern Indiana, the Mississippi Valley, North Dakota and even Yellowstone. This exchange system foreshadows the later Hopewell Interaction Sphere (Caldwell 1964) in scope with materials from the Rocky Mountains found in the same mortuary contexts as those from the Gulf Coast and Great Lakes.

As discussed earlier, trade, exchange and ritual are all used in social contexts to create and maintain relationships, compete for social position and influence, establish alliances, and for many other socially critical functions. The Late Archaic may then be seen as a period in which exchange and interaction increases in scale, scope, and elaboration. Small-scale societies begin to employ social networks in the formation of more structured systems involving the seasonal aggregation of larger populations, the appearance or elaboration of corporate groups, and the use of mortuary ritual (and likely other ritual activities) in creating and maintaining social identity, position, and rights. Thus the Late Archaic and subsequent transitional Early Woodland period is one of social change that heralds a trend of increasing social complexity that culminates in later Hopewell, Mississippian, and Upper Mississippian societies.

Distribution of Late Archaic Populations

Interaction in the form of gift exchange facilitated formalized social relations between and within Late Archaic communities and societies. But while we can note the appearance and growing importance of social interaction and the exchange of gifts, we need more information to examine the functioning of the gift economies that moved exotic materials throughout the region. One of these knowledge gaps involves identifying the location of Archaic populations and societies during the period from 4000 to 2000 BP.

Where are those societies and who has access to what resources? What is the geography of Late Archaic populations and social interaction? We can approach this question by looking at the distribution of sites that date between 4000 and 2000 BP (Figure 4.5). The distribution of sites is non-random, and this map shows a general trend of denser concentrations in the southern part of the region, notably around Lake Winnebago and the southern end of Green Bay. Additional sites are found in the Black and Wisconsin river valleys, and in the headwaters region of the Northern Highlands. Site density in those areas is more than two standard deviations higher than the mean site density for this region.

Another important factor is the identification of named cultural complexes, thus factoring in cultural differences between contemporary or partially contemporary communities. As discussed earlier, the western Great Lakes region contains several contemporary Late Archaic complexes, including the Burnt Rollways Phase in the Northern Highlands (Salzer 1974), and the Late Archaic communities participating in the Red Ocher complex (Ritzenthaler and Quimby 1962) in the area around Lake Michigan and Lake Winnebago. The less thoroughly defined Preston and Durst phases occupy the Driftless Region in the southwestern portion of the region (Stoltman 1997:134-137).

Although the location of individual sites and formally recognized archaeological complexes is known, the relationship between these and past populations, societies, and communities is less clear. The functioning of past gift economies and interaction between communities benefits from a detailed understanding of the location of those communities, both in relation to one another and in relation to resources that function as gifts or exchange items.

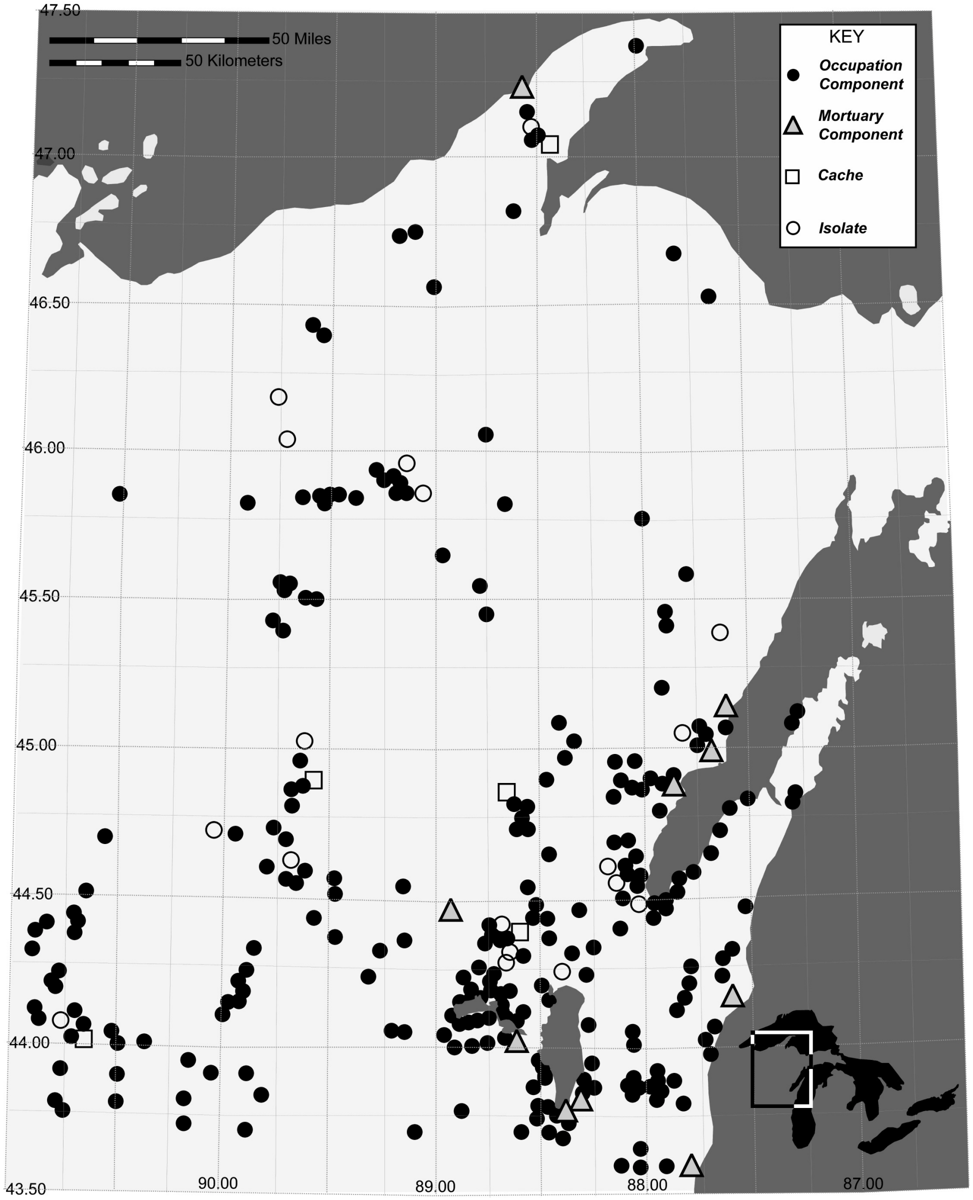


Figure 4.5. The distribution of sites dating between 4000 and 2000 BP.

The remainder of this chapter will use the distribution of sites dating between 4000 and 2000 BP to identify areas intensively used by different Archaic populations in the region.

Archaeological sites represent the physical remains of the behavior of Archaic populations, so the distribution of sites is partially dependant on the distribution of those Archaic societies and their mobility practices. However, the distribution of archaeological sites is also dependant on several other factors, including the preservation of the archaeological resource, visibility of preserved sites, potential for discovery and identification, and the likelihood of recording and documentation.

This section explores one approach to exploring the distribution of Late Archaic populations in the western Great Lakes. Using regression analysis, the effect of modern population density on site discovery is assessed, then removed from the data to provide a less biased view of Archaic population geography.

Relationship between Modern Population and Site Distribution

Modern populations have a direct effect on site discovery, preservation, and documentation, thus introducing a potential source of bias into the distribution of recorded archaeological sites. Modern populations affect site discovery by:

1. Development that increases site visibility and enhances the potential for discovery and identification
2. After the 1960s, development increasingly required archaeological survey and enhanced the opportunities for the recording and documentation of discovered sites.

Euroamerican settlement also has the potential to adversely affect site preservation, especially in the period before the advent of CRM laws in the 1960s and 70s. Sites can be and were destroyed through development and agricultural practices without documentation or investigation. Thus the modern population has a complex relationship with site discovery that can both enhance and degrade opportunities to preserve, find, and ultimately document archaeological sites. Further complicating this relationship is the shift in Euroamerican settlement from the coastal to interior areas following the development of railroads in the nineteenth century. However, the relationship is expected to be a positive one; that is, an increase in modern population should result in increased opportunities for site discovery and documentation. As a result, modern population has the potential to create apparent clusters of recorded archaeological sites that reflect increased opportunities for site discovery rather than the actual distributions of past populations. If we seek to understand the geography of past populations, this potential bias must be addressed.

Methods. Several steps are needed to convert the documented distribution of Late Archaic archaeological sites into an approximation of past population geography. First, the effects of modern population on site discovery must be addressed. Following that, those effects must be removed from the distribution of known sites to yield a clearer and less biased view of the distribution of past populations.

The area chosen for this study (Figure 4.6) includes thirty one counties in northern Wisconsin, and nine counties in Michigan's western Upper Peninsula. This is a region bordered on the north by Lake Superior and on the east by Lake Michigan, and includes all three major watersheds. The distribution of known archaeological complexes suggests that these may have been meaningful distinctions during the Archaic period, with the sites participating in the Red Ocher system largely occupying the Lake Michigan basin, Burnt Rollways at the headwaters region in the north, and the Preston and Durst phases in the Mississippi valley.

The locations, affiliations, and site types for 465 recorded components (Appendix II) dating between 4000 and 2000 BP were collected from the site files of the Wisconsin Historical Society and Michigan's Office of the State Archaeologist. Modern population data was obtained from the 2000 US Census.

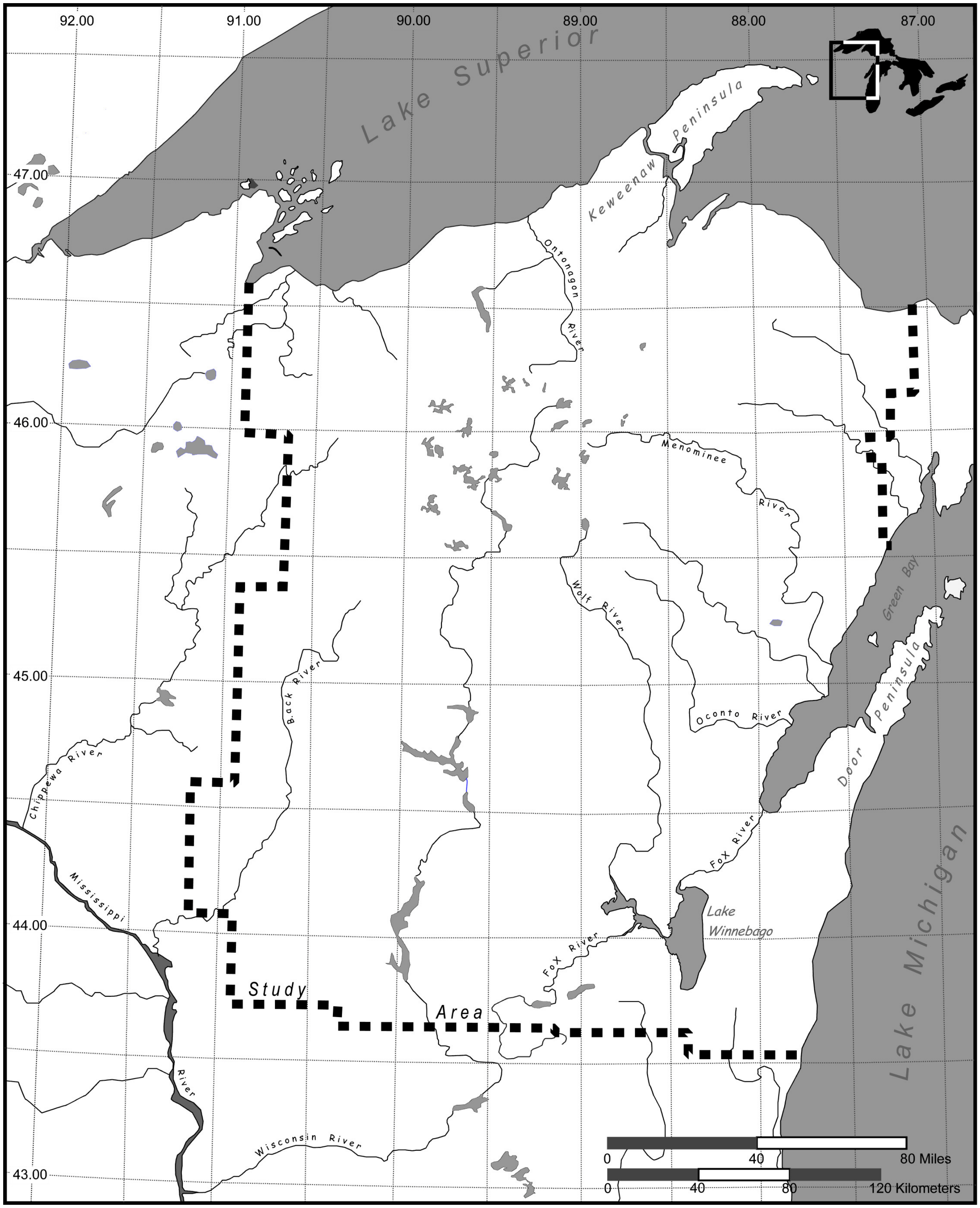


Figure 4.6. The forty county area used to examine the distribution of Archaic populations between 4000 and 2000 BP.

To more accurately compare modern population and site location, the study area was divided into 219 quadrats measuring 0.25 degrees latitude by 0.25 degrees longitude. The number of sites and people was compiled for each quadrat. These data were then used to map and compare Archaic site density (Figure 4.7) and modern population density (Figure 4.8). A few similarities are readily observed, most notably the concentration of both modern population and Archaic sites in the vicinity of Lake Winnebago and southern Green Bay.

This relationship between population and site frequency was then statistically explored using linear regression (Figure 4.9). A weak positive relationship was found in which 17 percent if the variability in site location could be attributed to modern population density. A better fit is obtained by using a polynomial regression (Figure 4.10), which shows a more complex relationship between population and site density that can account for more than 22 percent of the variability in site location. Site frequency is found to increase as population increases up to around 75,000 people per quadrat, or roughly 300 people per square mile. Above 300 people per square mile, site frequency decreases. This demonstrates a complex relationship between *site discovery* factors—which dominate below population densities of 300 per square mile—and factors adversely affecting *site preservation* which come to dominate at population densities of 300 per square mile.

While modern population density can account for roughly a fifth of the variation in Archaic site locations within the region, other factors are responsible for the remaining three quarters. These include variability in site preservation, environmental conditions that affect site visibility, and past social factors including availability of resources, recognized territories and rights of use, and the presence of other social groups.

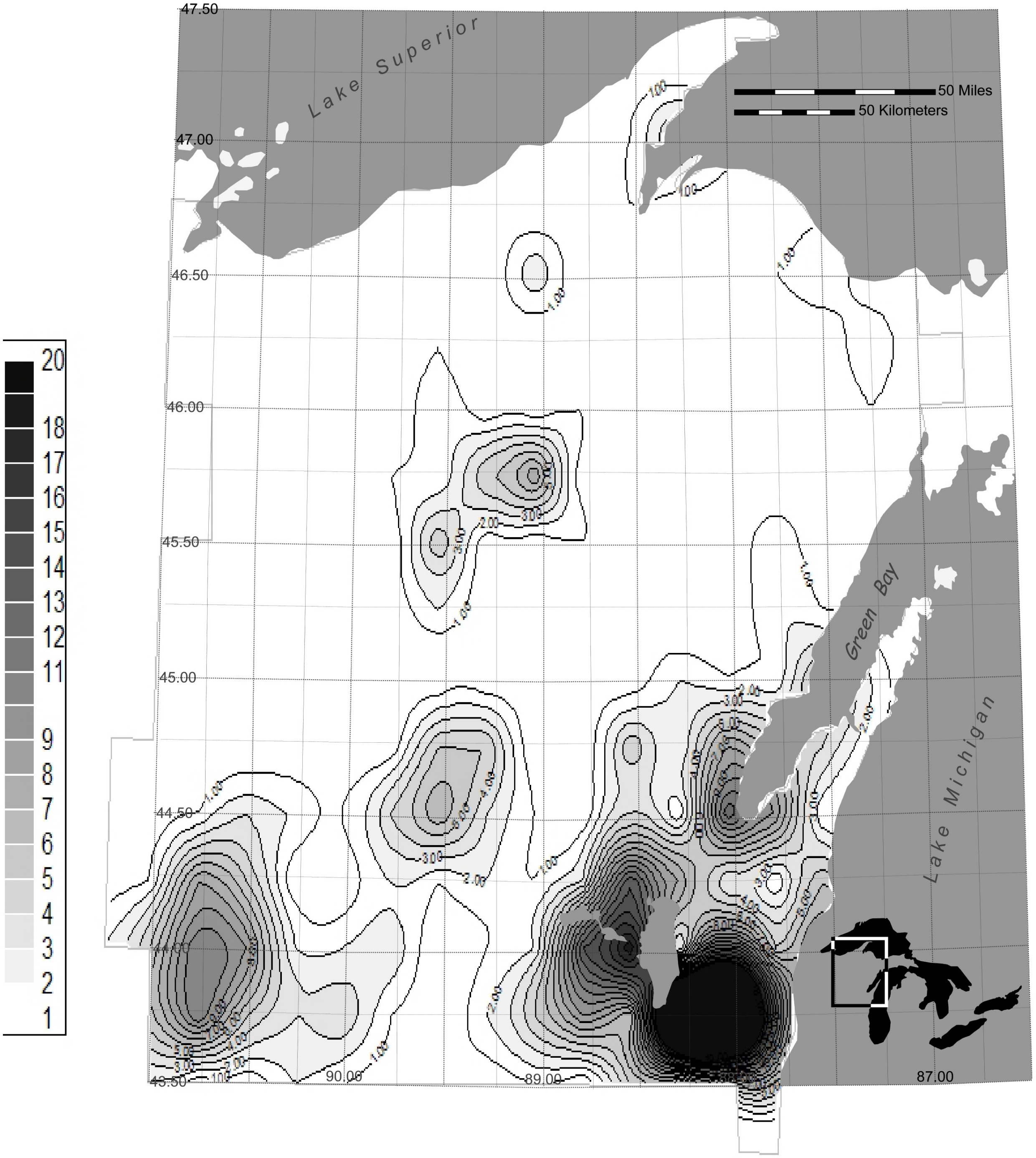


Figure 4.7. Distribution of Archaic components that date between 4000 and 2000 BP in the study area.

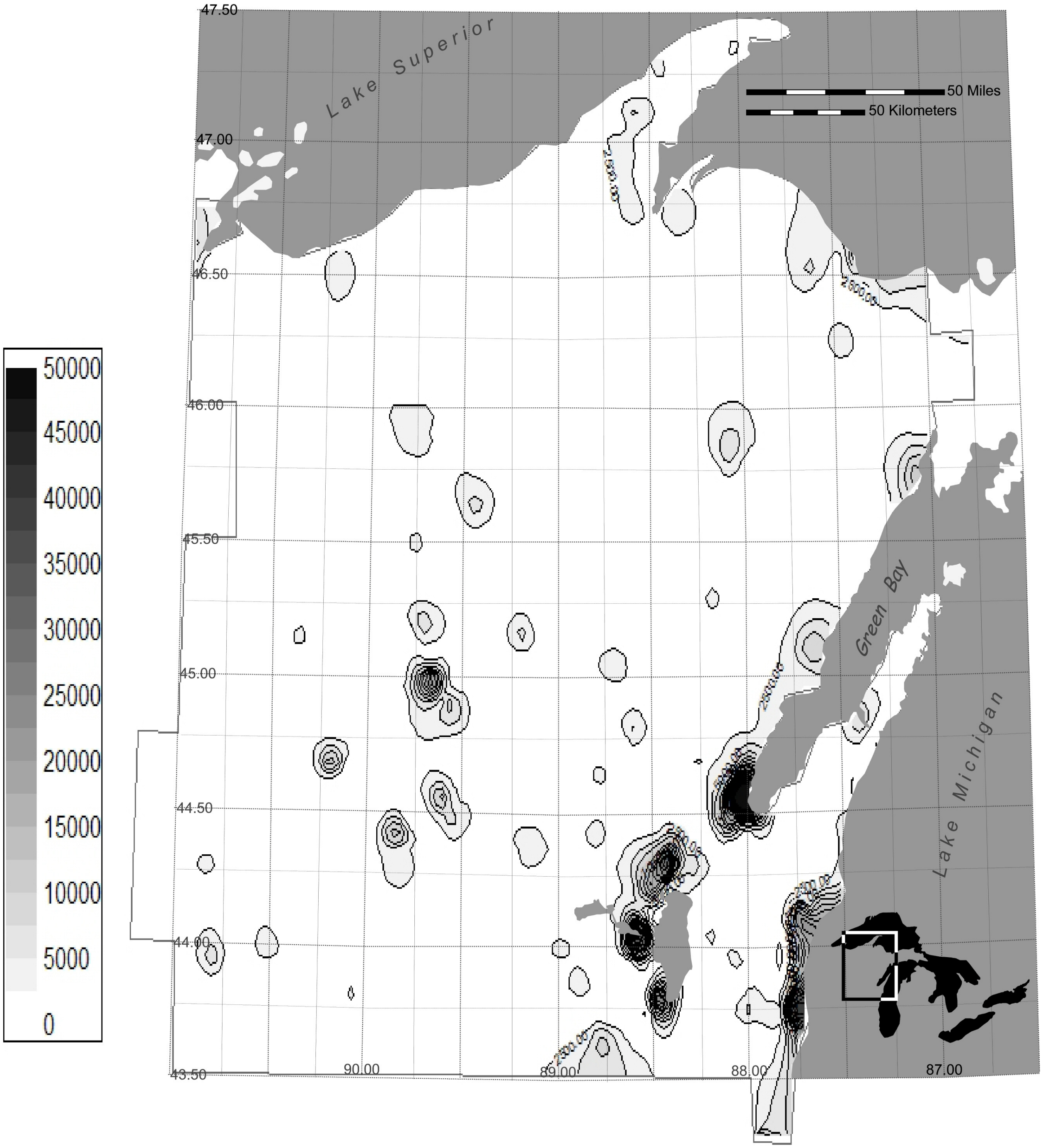


Figure 4.8. Modern population distribution, based on the 2000 US Census data.

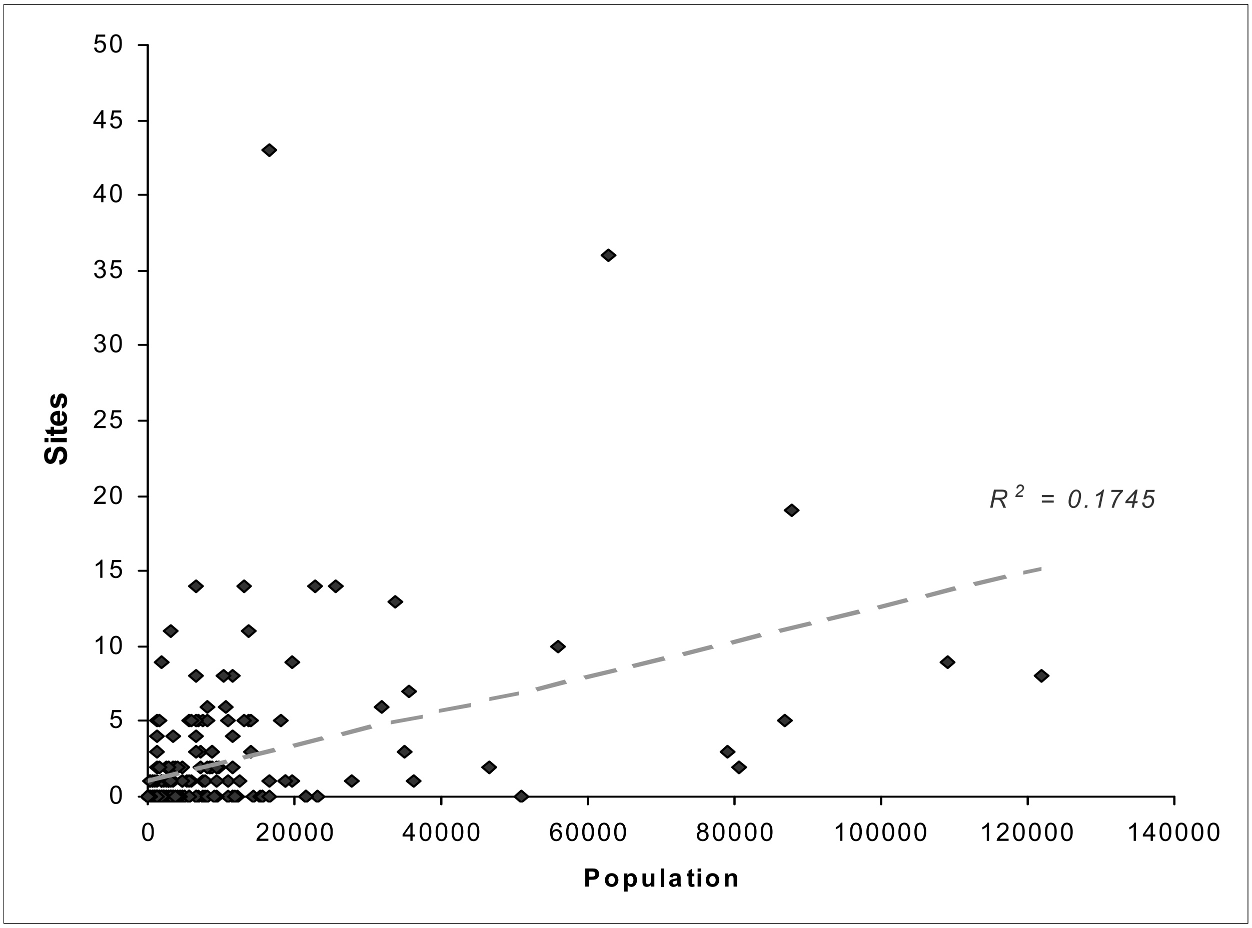


Figure 4.9. Linear regression of the relationship between modern population as the independent variable, and numbers of sites as the dependant.

After determining the nature and strength of the relationship between modern population and site distribution, we can now turn to removing that influence and examining the distribution of Archaic sites in the region. Residual values from the polynomial regression represent the variability remaining in the sample. Plotting these residual values (Figure 4.11) shows the distribution of Archaic sites after modern population bias has been removed from the sample.

This plot represents a less biased view of the distribution of Late Archaic activities on the landscape, and reveals several statistically significant site clusters. Three clusters represent site densities greater than two standard deviations above the predicted values; one covers an area

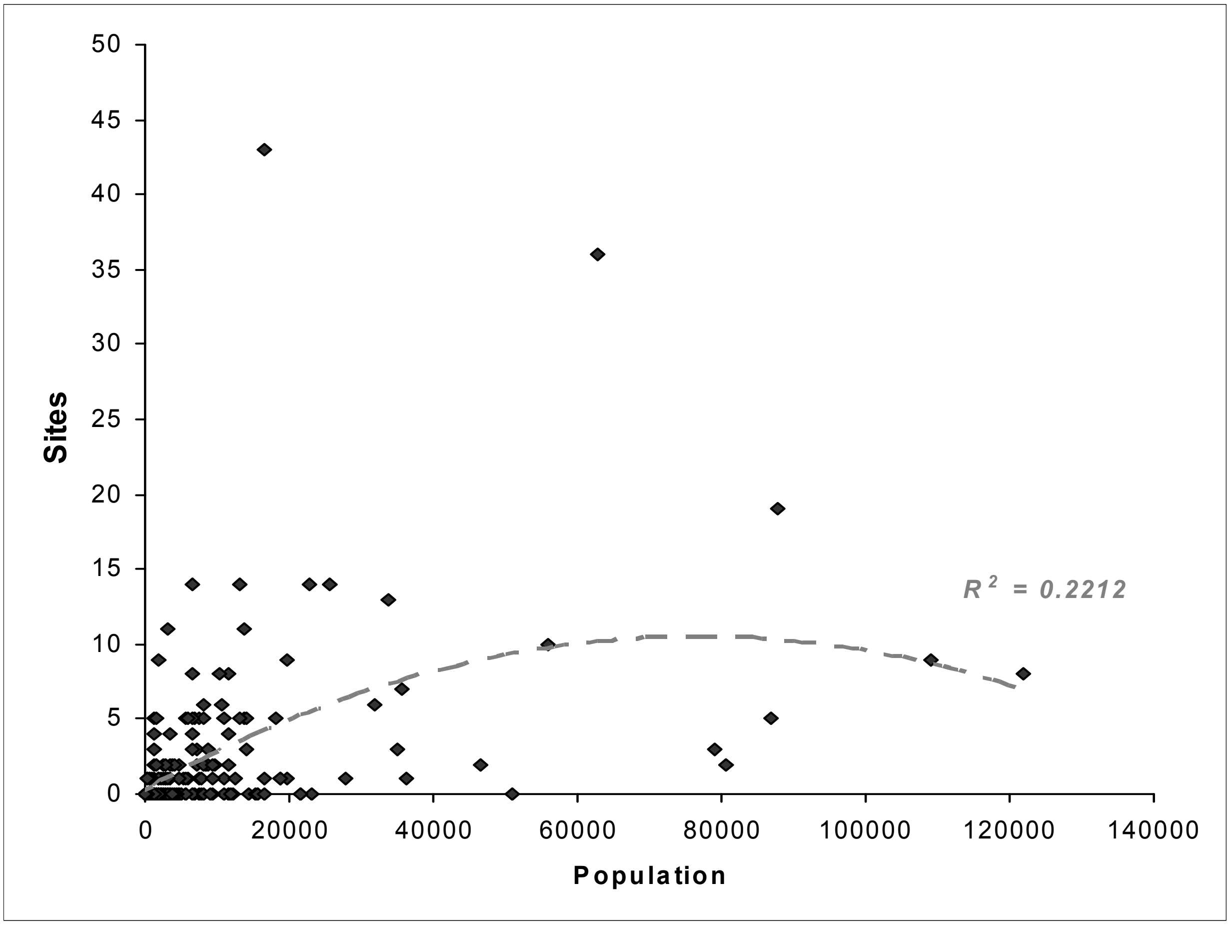


Figure 4.10. Polynomial regression of the relationship between modern population as the independent variable, and numbers of sites as the dependant variable.

from Lake Michigan to the southern parts of Lake Winnebago. A second lies around the confluence of the Fox River with Lake Butte des Mortes, immediately west of Lake Winnebago. The third lies near the lower to middle Black River in the Mississippi basin. Two additional clusters represent site densities greater than one standard deviation above the predicted values; these are located along the southwestern shore of Green Bay and in the Northern Highlands at the headwaters of the Wisconsin and Wolf Rivers.

Discussion. Sites of the 4000 to 2000 BP period are not evenly or randomly distributed in the Western Great Lakes. Late Archaic components, and by extension populations, clustered more strongly in certain areas than others. Within the study area, every view of the data suggests that areas around Lake Winnebago, lower Green Bay, the lower to middle Black River, and the Northern Highlands were preferentially used by Archaic populations.

These statistically significant clusters of Archaic components perhaps represent distinct Late Archaic communities. Each of these clusters correspond with named archaeological complexes; the Northern Highlands cluster corresponds with the named Burnt Rollways phase, and the three clusters around Green Bay and Lake Winnebago correspond with the area known to contain Red Ocher components. The Black River cluster may have its closest affiliations with the Preston and Durst phases of the Driftless Region and Mississippi Valley. It would seem that different populations occupied the Lake Michigan basin, the Northern Highlands, and the Mississippi Valley. Additional clustering within the Lake Michigan Basin suggests several populations or communities within this area, each perhaps associated with different mortuary sites along Green Bay, Lake Winnebago, and Lake Michigan. These may represent contemporary communities, but the resolution of the data cannot rule out changing centers of population in the Lake Winnebago—Green Bay region during the course of the later portions of the Archaic.

The density of Archaic components is quite low in the north, despite intensive survey on the nearly 3 million acres of federal lands that are present in the area. With the exception of the Burnt Rollways phase at the headwaters of the Wisconsin, Wolf, and Menominee Rivers, few Archaic components are present. This becomes particularly noteworthy in regard to access to primary copper deposits in the Keweenaw Highlands. A handful of Archaic components are found near this region in northern Michigan, notably near Lake Gogebic and along the Ontonagon River. These include the Duck Lake site, Alligator Eye, and Gogebic County Park

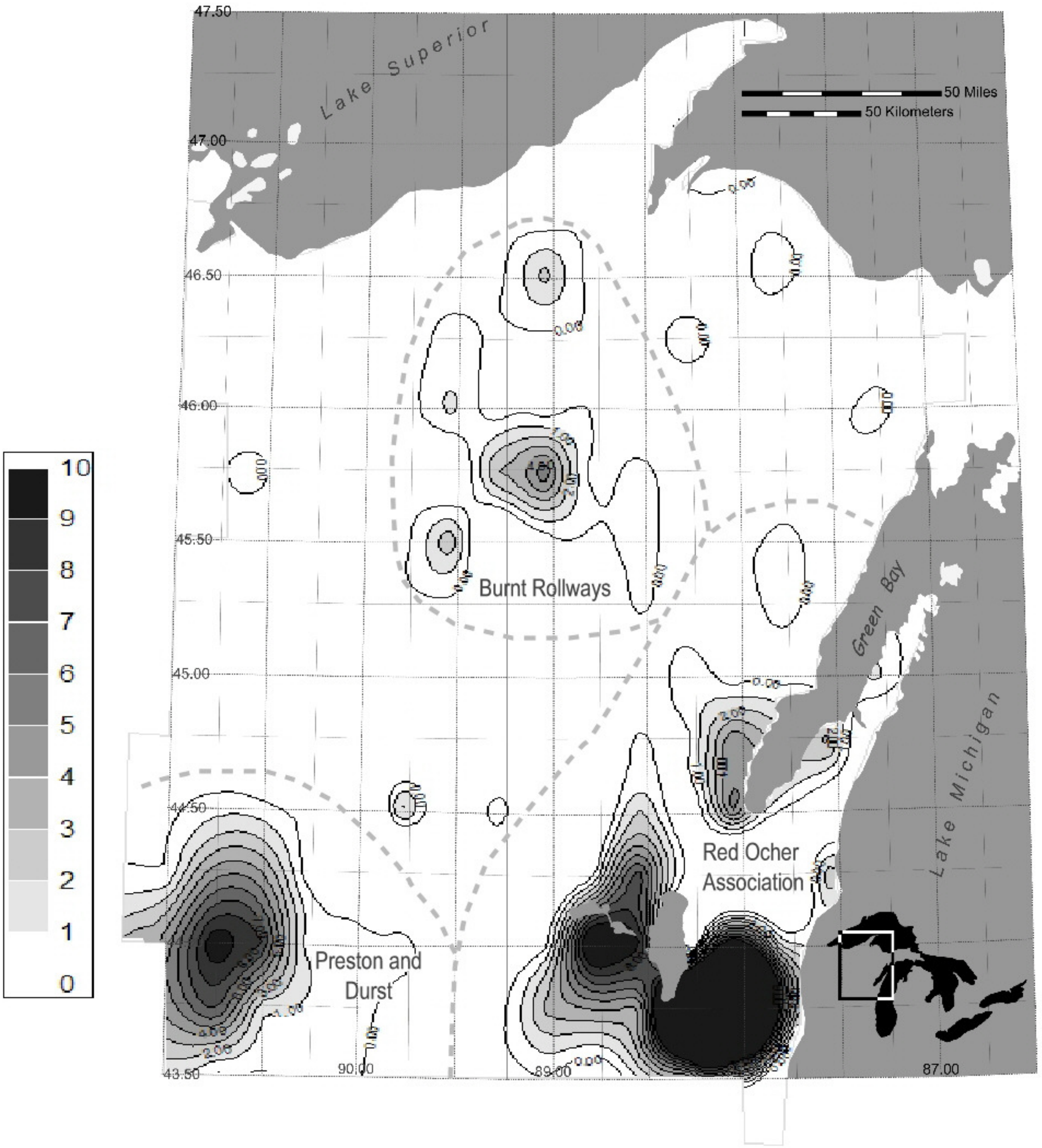


Figure 4.11: Plot of the residual values from the polynomial regression of Archaic site frequency and modern population. Archaic components are shown to cluster significantly around Lake Winnebago, lower Green Bay, the middle Black River, and the Northern Highlands.

sites, which have their closest affiliation with the Burnt Rollways phase sites to the south (Hill 1994, 2007). Farther north on the Keweenaw Peninsula there are a handful of sites near the Portage River and farther north at Lac LaBelle whose associations are less clear (Martin et al. 1993).

The Lake Superior basin portion of the study area appears to have lacked a substantial Archaic population. Duck Lake and Alligator Eye provide the best associations between the populations that utilized this area and known Archaic populations, and those associations are with the Burnt Rollways phase. It would seem that access to the primary and dense secondary copper sources was likely conducted by small non-resident groups during the course of seasonal movements.

In conclusion, modern population has an affect on the discovery and recording of Archaic archaeological sites. Over 22 percent of the variability in the location of Late Archaic sites in the study area can be attributed to modern population density. With modern population densities below 300 per square mile, increasing population increases site discovery and recording, yet modern population densities above 300 per square mile leads to fewer sites being recorded. This may result from the destruction by development of sites in densely populated locations before they can be adequately recorded, perhaps prior to the onset of significant CRM legislation and policies in the late twentieth century.

The discovery and recording of sites in a particular area is a product of several factors: 1) past prehistoric activity resulting in an identifiable archaeological resource, 2) preservation of that resource through time, 3) visibility of that resource to modern recorders, and 4) discovery, identification, and recording of the site. Modern population density has a direct effect on visibility and discovery of sites through development projects that both expose archaeological resources and often require surveys to identify archaeological resources. Correlating modern population density with the number of recorded sites provides a means of removing one source of bias in the identification of past geographies by removing these modern population effects.

In this case, modern population density can account for nearly a quarter of this variability. Residual values capture the remaining variability, related to the preservation factors and—most importantly—past social behavior that resulted in the formation of those sites.

Within the study area, Late Archaic populations are found to have preferentially occupied lands in the Green Bay and Lake Winnebago areas, the middle Black River, and the Northern Highlands. Each of these may represent the core area for one or more populations and multiple communities, but their association with named archaeological complexes suggests that they do represent distinct and identifiable Archaic social groups. Of these, Burnt Rollways has the most direct and unrestricted access to primary deposits of copper in the Lake Superior basin, though copper is also available in the glacial landforms that cover northern and eastern Wisconsin. Interaction with communities downstream on the Wolf, Menominee, and Wisconsin rivers could then have spread copper resources out from the Northern Highlands to communities in the Mississippi Valley, Lake Winnebago region, and Green Bay. If so, the trace element analysis of copper in Late Archaic sites, discussed later in Chapter Eight, should document this interaction between Northern Highland communities and their downstream contemporaries.

CHAPTER FIVE

THE DEVELOPMENT OF LATE ARCHAIC REGIONAL SYSTEMS

The appearance of items manufactured from exotic materials during the Late Archaic may signal more than the simple movement of goods. As shown earlier, exchange is powered by more than just economic need; exchange is a powerful force for "social reproduction" that helps to form and confirm alliances between diverse groups and it provides goods that function at local levels to signal important social distinctions and meet group ritual needs (Saitta 2000:151).

In the previous chapter, we saw that significant changes affected Late Archaic populations in the Midcontinent. This is, in part, a result of the relationships created and benefits received through increasing exchange. The model of exchange discussed in Chapter Two makes five testable predictions that allow us to address this question; 1) as trust is established through repeated iterations of exchange, interaction will become more common and exchange goods will be more readily available and come from greater distances, 2) differential access to exchange may lead to the development of inequities that provide some with access to exchange goods and others with little benefit, 3) social rules will be developed, such as the standardization of exchange materials to convey clear and recognizable symbols across large social distances, to formalize and standardize the process and materials of exchange to reduce risk, 4) exchange is risky and may lead to increased conflict between communities, and 5) social changes may occur that reflect changing social roles of males, females, and children. The first four of these are explored in this chapter, while social change is explored in depth in the following chapter.

These four characteristics reflect more than just exchange. Occasional and less formal exchange may move materials over long distances through down-the-line models that feature numerous small-scale and relatively local interactions over long periods of time (Renfrew 1972). Instead, the characteristics explored here signal the development of regional systems of interaction and measure three of Hegmon and Plog's (1996) dimensions of such regional systems; 1) the exchange of information, 2) the exchange of material goods, and 3) the development of sociopolitical relations between communities.

In Table 2.1, an approach to exploring these questions was outlined. Comparisons between the Middle Archaic populations and the Late Archaic populations will be used to highlight any changes occurring during this time period. The establishment of trust, intercommunity relationships, and scale of interaction will be measured by assessing both the frequency and source distance of exotic materials in mortuary populations from the Middle Archaic and Late Archaic. Differential access to exchange benefits within communities will be assessed by measuring the distribution of exotic goods within mortuary populations. The development of social rules regulating exchange will be explored by examining the methods and materials used to produce large bifaces that are prominently featured in Late Archaic exchange systems (Figure 5.1) to identify standardization that would make them consistent, identifiable, and honest signals over large social distances. As a negative form of sociopolitical relations, conflict will be explored through an analysis of the demographics of mortuary populations as well as through an identification of trauma and signs of violence.

Methods

The Archaic mortuary components at Oconto, Reigh, and Riverside were used in this analysis. These three sites are all located in Lake Michigan basin in eastern Wisconsin and the Upper Peninsula of Michigan (Figure 5.2), and may represent shifting centers of mortuary activity from

Figure 5.1. Mortuary bifaces from burial feature 27 at the Riverside Site (Courtesy of the Milwaukee Public Museum).

the Middle Archaic through the initial Woodland periods (Figure 5.3). As shown in Chapter Four, Oconto is an early Middle Archaic cemetery located upstream from the mouth of the Oconto River on the western shore of Green Bay. One of the original "Old Copper" sites (Ritzenthaler 1957), Oconto has produced five uncalibrated radiocarbon dates, spanning the period from 7510 to 4540 BP, which place the site firmly in the Middle Archaic (Ritzenthaler 1970). At least of 48 individuals were interred at this cemetery site using a variety of burial types (Pfeiffer 1977:82; Ritzenthaler and Wittry 1957).

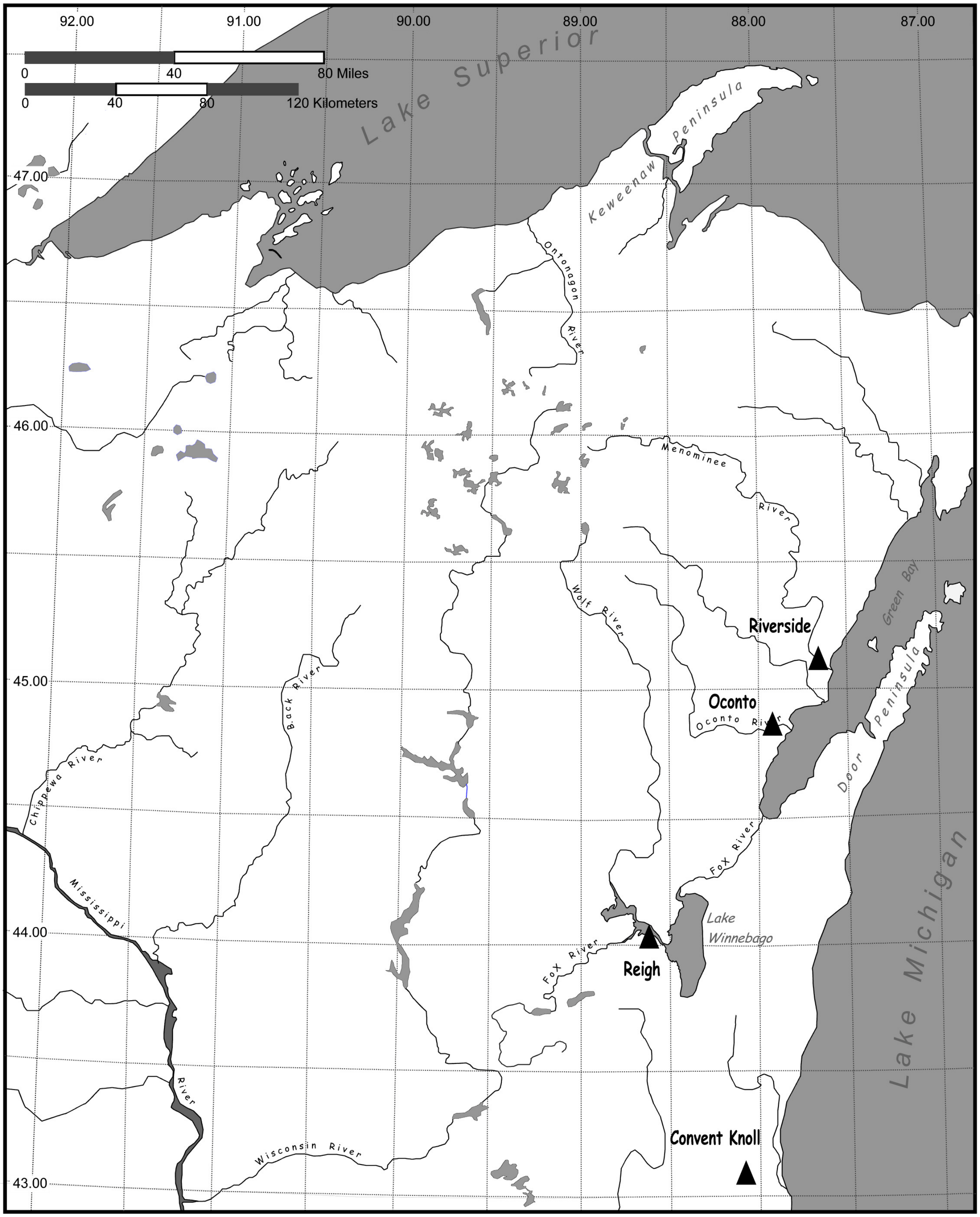


Figure 5.2. Location of the Riverside, Oconto, Reigh, and Convent Knoll sites used in this analysis.

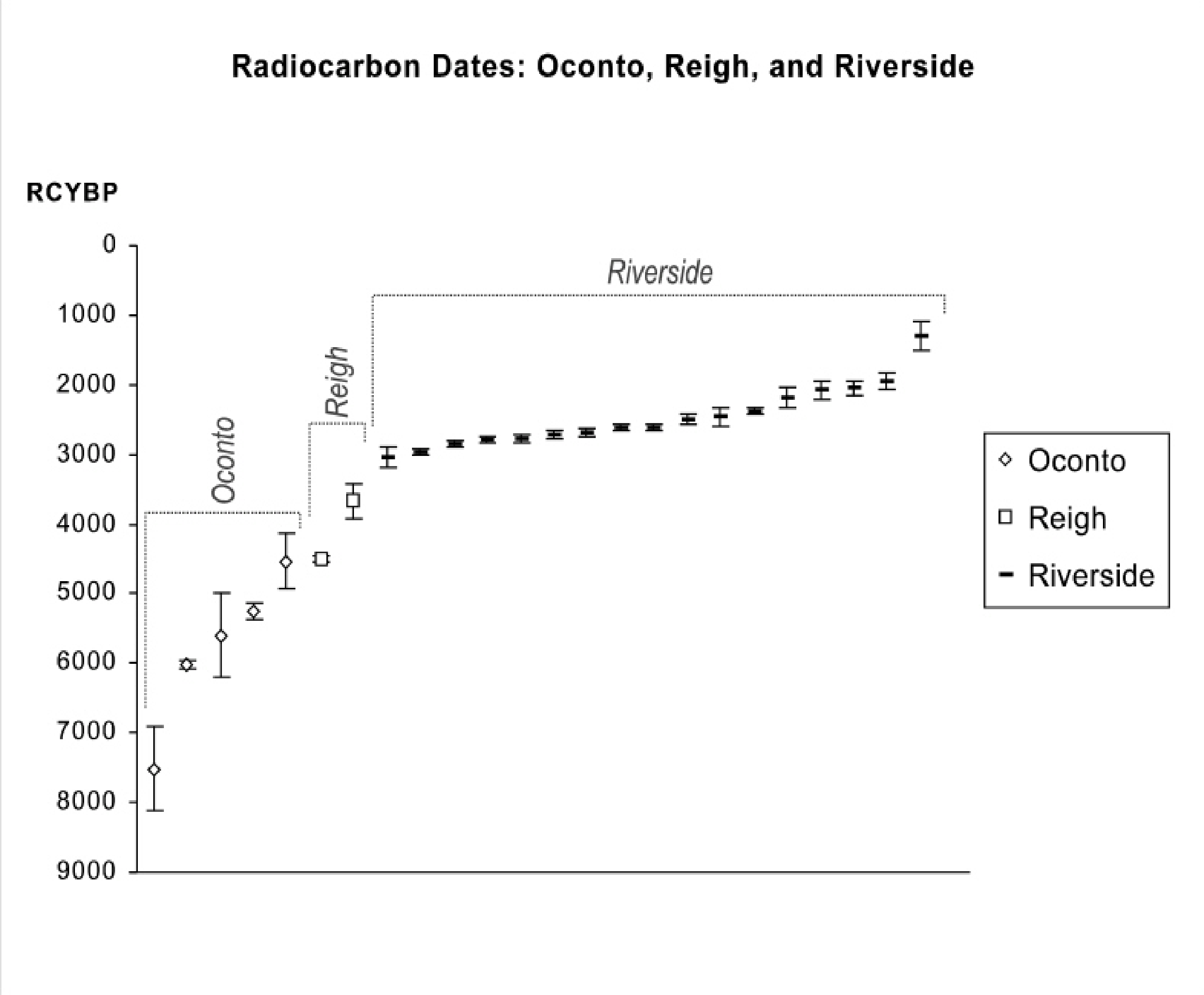


Figure 5.3. Chronology of the Middle Archaic Oconto, and Late Archaic Reigh and Riverside sites. Dates represented are in uncorrected radiocarbon years before present.

Dating between 4490 and 3660 BP, the Reigh site is used in this analysis to represent the late Middle Archaic period. Located just west of Lake Winnebago on the Fox River system, Reigh has a minimum of 47 individuals buried as primary and secondary interments (Table 5.1) and cremations in 23 burial features (Baerreis et al. 1954; Pfeiffer 1977).

The Late Archaic to initial Woodland period is represented by the Riverside cemetery. Located on the Menominee River upstream from the western shore of Green Bay, Riverside represents the burial of a minimum of 76 individuals in 58 burial features (Pleger 2000). Dating between 3040 and 1950 BP, these burials include primary and secondary interments as well as cremations, and a few individuals are buried with lavish quantities of exotic bifaces and copper artifacts. Of these, only 39 burial features and 51 individuals were included in the following analysis due to poor preservation, curation in multiple institutions, and the recent repatriation of a portion of the collection (Table 5.2).

Data related to the numbers and metrics of grave goods, their material of manufacture, and the sources of that material, were collected from published sources and from collections housed at the Milwaukee Public Museum and the Wisconsin State Historical Society. These data were used to examine changes in the scale and frequency of exchange from the late Middle to late Late Archaic. Metric data of mortuary bifaces from the Riverside and Reigh sites were used to create coefficients of variation to explore the development of specialized production and standardization of these widely exchange and socially important materials. Previously conducted analyses of age and sex (Binford 1972; Papworth 1967; Pfeiffer 1977) were used to construct population demographics to identify changes in mortuary populations that may be related to mate selection or warfare.

Results

1. Access to Exchange Networks and Scale of Interaction

Does the scale of regional interaction increase during the Late Archaic, and do interactions become more frequent? To address this question, data from the Middle Archaic Reigh Site are compared with those from the Late Archaic and Early Woodland Riverside Site to identify trends in the frequency of non-local materials and distances to their source among mortuary goods.

Table 5.1. Reigh site feature data.

Burial	Copper Feather	Copper Beads	Copper Points	Antler Points	Large Hafted Biface	Hafted Biface	Antler Tine	Antler Axe Handle	Antler Handle	Ow Leg	Bone Tube	Gorget	Shell Beads	Crane bill	No Indiv.
4	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
5	0	0	0	0	0	3	0	1	0	0	0	0	0	0	1
6	22	0	0	2	0	0	0	0	0	0	0	0	0	2	8
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
8	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
10	0	0	0	0	0	0	1	0	0	0	0	0	0	0	6
11	0	0	0	0	1	0	0	0	1	1	1	0	0	0	3
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
13	0	12	0	0	0	0	0	0	0	0	0	1	4	0	3
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
18	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
21	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
23	0	0	1	0	1	0	0	1	0	0	2	0	0	0	1
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
25	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2
26	0	0	1	0	1	0	0	0	0	0	0	0	0	0	2
N= 23	22	12	3	2	5	5	1	2	1	1	3	1	4	2	47

Table 5.2. Riverside site feature data.

Feature		Wyan. Biface	Wyan. Other	Burl. Biface	Shell Beads	Obsid.	KRF	Copper Beads	Copper Celt	Coper Stemmed Point	Copper Conical	Copper Crescent	Copper Awl	Copper Other	Other Non Exotic	Total	No Indiv
3		0	21	0	0	0	0	107	0	0	0	0	0	0	1	129	3
4		0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1
6	S	0	0	0	0	0	1	0	0	6	2	0	1	33		43	1
7		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
9		0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
10	S	0	0	0	0	0	0	0	0	0	1	0	0	1	0	2	1
13		0	0	0	0	0	0	83	1	0	0	0	0	0	0	84	1
14	S	0	0	0	0	1	0	102	0	0	0	0	0	0	1	104	2
17		0	2	0	0	0	0	332	0	0	0	0	0	0	2	336	3
19		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
21		0	0	0	0	0	0	0	0	4	0	2	2	0	1	9	1
22		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
25		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
26		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
27		8	1	0	2	0	0	0	0	0	0	0	2	0	2	15	1
28		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
29		43	0	0	0	0	0	210	0	0	0	0	0	0	0	253	2
30		13	0	0	0	0	0	0	0	0	0	0	0	0	1	14	2
31	a	12	0	1	0	0	0	0	0	0	0	0	0	0	0	13	1
31	bc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
32	a	0	0	0	0	0	0	0	0	1	0	1	0	0	0	2	1
32	bcd	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
35		0	0	0	0	0	0	0	0	0	0	0	0	0	7	7	1
36		0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
37	ab	8	0	0	0	0	0	108	1	0	0	0	0	0	0	117	2
37	c	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	1
38		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
39		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
41		0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	1
43		0	0	0	0	0	0	1	0	0	0	0	0	0	1	2	1
44		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
45		0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	1
52		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
56		0	0	0	0	0	0	0	0	0	0	0	1	0	4	5	1
63		0	0	0	0	0	0	0	0	0	0	0	0	0	114	114	1
68		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
69		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
74		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
80		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
N=	*39*	84	24	1	2	1	1	943	2	11	3	3	8	35	146	1264	51

The presence and scope of exchange networks is demonstrable through the source locations of materials found with any one component. A total of 125 items were interred with a minimum of 45 individuals at Reigh, producing an average of 2.8 items per individual (Figure 5.4). The vast majority of these materials were manufactured from antler, bone, copper, galena chert, and Prairie du Chien chert; all of which are available within a 200 mile radius of the site (Figure 5.5a). Only one item, a sandal-sole gorget (Figure 5.6), was manufactured from a material whose source lies farther than 200 miles from the site. This gorget was manufactured from marine conch shell from the Gulf of Mexico, which is over 900 miles to the south (Baerreis et al. 1954).

In contrast, the Riverside site produced over 1264 items interred with a minimum of 51 individuals, for an average of 24.78 items per individual (Figure 5.4). These figures exclude items that may have been included in the fill, such as lithic debitage, or that are fragments of bark containers or textiles. These numbers must be taken as an approximation, since many of the grave goods such as beads remain poorly counted. Even allowing for error in these figures, a significant scale difference remains between the late Middle Archaic Reigh site and the later Riverside site.

Similarly, the scale of interaction that produced these goods has also expanded. While a significant portion of the grave goods are manufactured from copper and lithics, found within 200 miles of the site, over 11 percent are manufactured from sources between 400 to 500 miles distant (Figure 5.5b). The majority of these are bifaces manufactured from Wyandotte chert originating in the Ohio Valley of southern Indiana and northern Kentucky. Two items (0.16 percent) were manufactured from marine shell, again over 1000 miles distant, two items are of

Knife River Flint from a distance of 800 miles, and one item is obsidian from Obsidian Cliff over 1100 miles away.

These results can be summarized as shown in Figure 5.7. This graph shows that the individuals at Reigh possess few goods, and that they come from relatively nearby. At Riverside, the average number of goods per person has increased by a factor of ten, and those goods have more distant sources. Reigh represents a community in which the benefits of exchange networks have not yet surpassed the cost/benefit or accessibility thresholds discussed in Chapter Two. However, the community at Riverside was actively participating in exchange networks that linked the northern Lake Michigan region to the lower Ohio Valley and beyond.

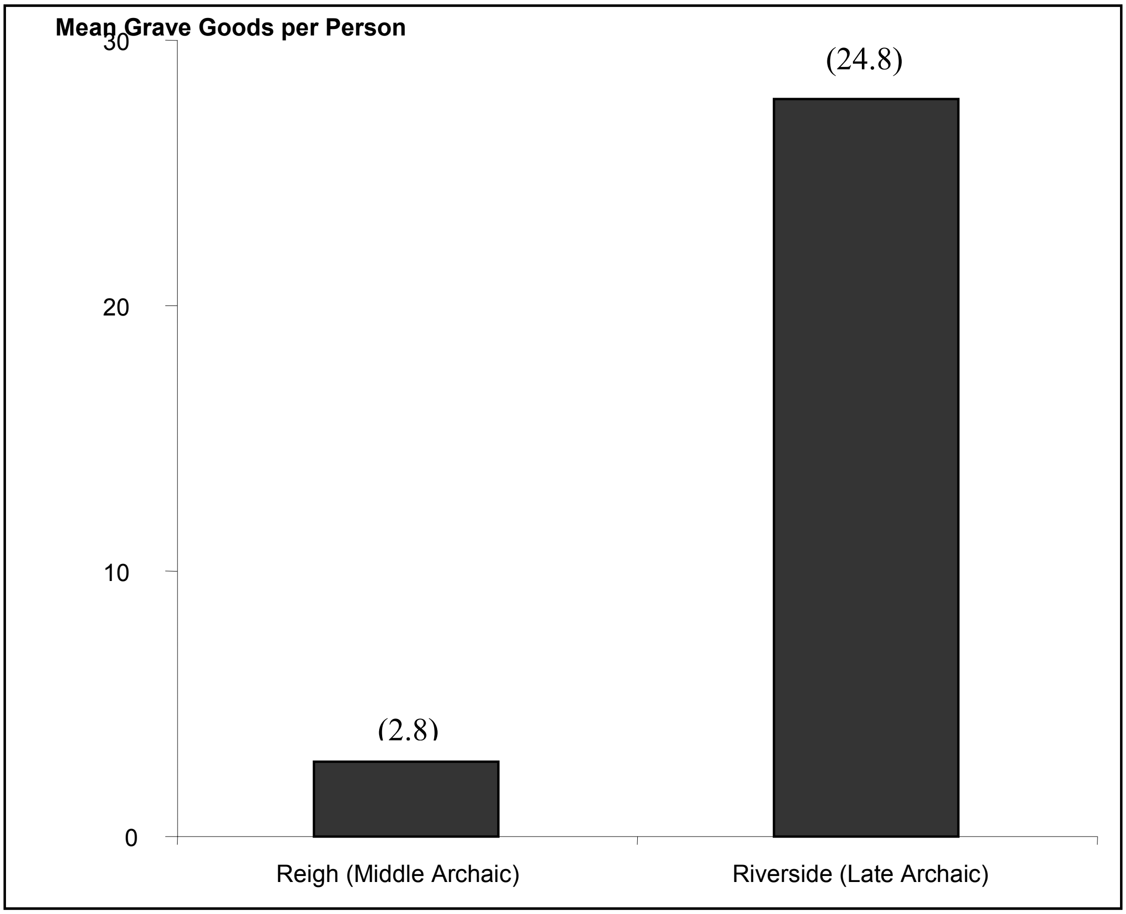


Figure 5.4. Changes in the average number of grave goods per individual from the Middle Archaic Reigh population to the Late Archaic Riverside population.

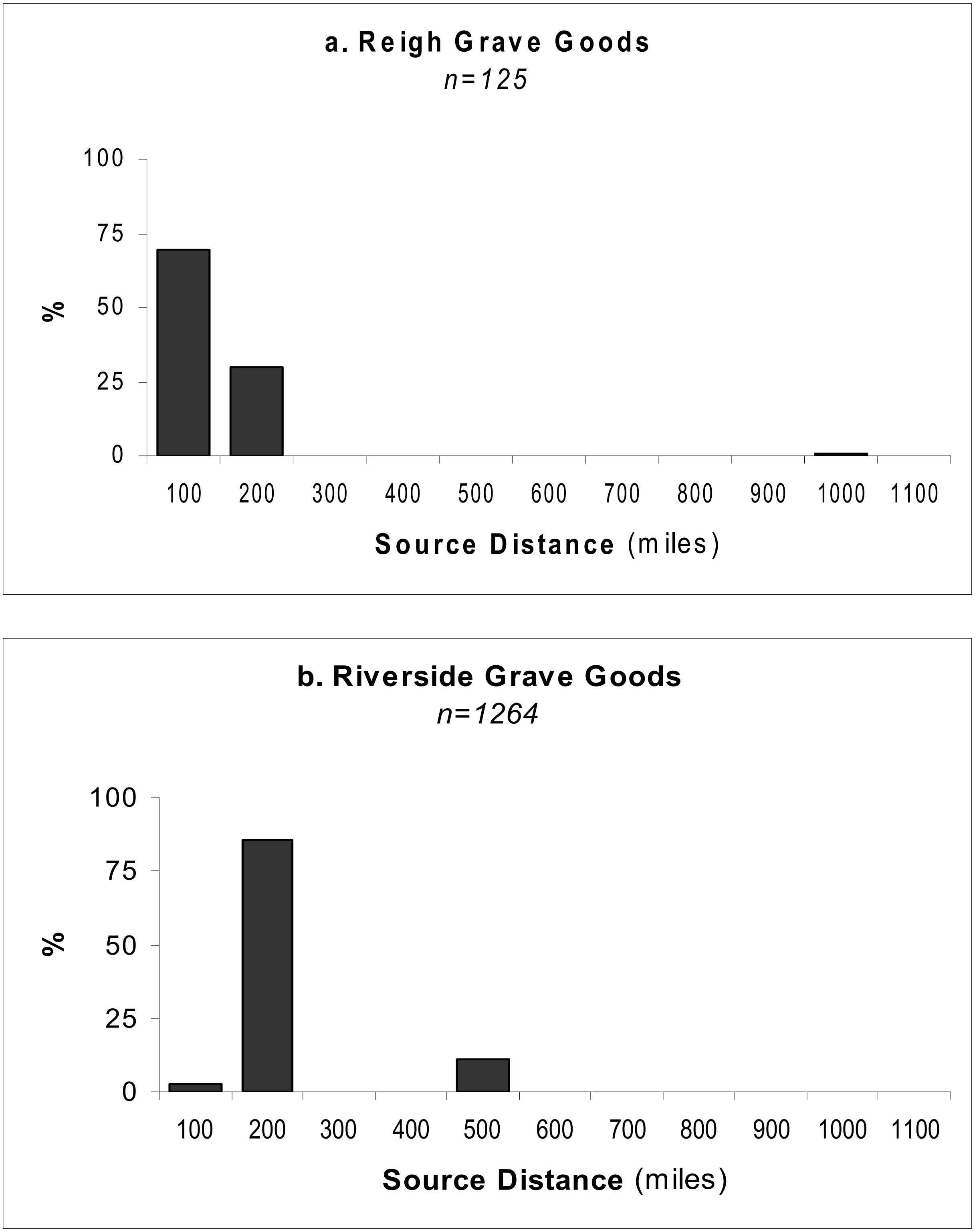


Figure 5.5.: Increasing source distance for grave goods from the Middle Archaic Reigh community to the Late Archaic Riverside community.

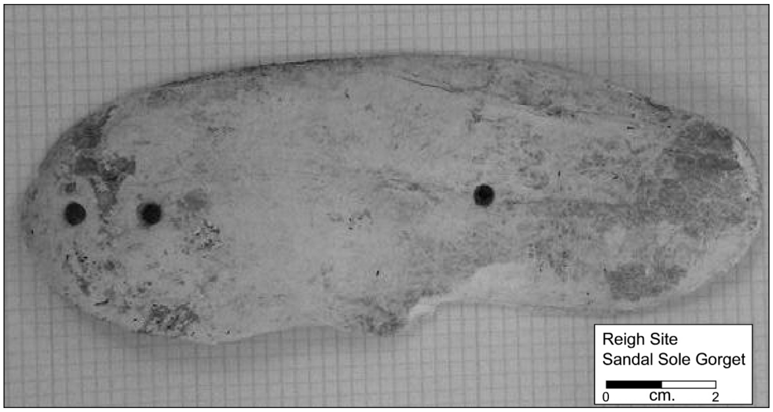


Figure 5.6. Sandal Sole gorget manufactured from distant marine shell and interred in Burial 13 at the Reigh Site (Courtesy of the Wisconsin Historical Society).

This community is one in which the cost/benefit or accessibility thresholds have been surpassed and in which exchange networks are actively contributing. The earliest dated feature at Riverside with Ohio Valley materials is Feature 29, with an uncalibrated date of 2960 ± 50 BP. Interestingly, with over 42 Wyandotte chert bifaces—more than three times the number of any other feature—this feature also has the greatest number of Ohio Valley items. While the earliest use of Riverside, dated to 3040 ± 150, resembles the mortuary practices at Reigh, less than a century later significant exchange networks had become important resources that link the Late Archaic populations of the western Great Lakes to the communities far to the south.

2. Differential Access to Networks

How is access to exchange benefits structured within the Riverside community? Does everyone share equally, or, as predicted in Chapter Two, do only a few individuals have access to the immediate benefits of exchange networks? Equal access to goods should follow a normal distribution, while if benefits are limited to a few 'brokers' who have access to exchange networks, the distribution of exchange goods should follow a power law distribution (Bentley

2003; Bodley 2003). The distinguishing feature of power law distributions is that, when plotted on a log-log plot, they appear as a straight line. Therefore, the functioning of exchange networks in which a few people have access, while the rest of the community relies on those individuals for access to non-local goods, should appear as a power law distribution when plotting the number of non-local goods against the cumulative frequency of individuals with those goods.

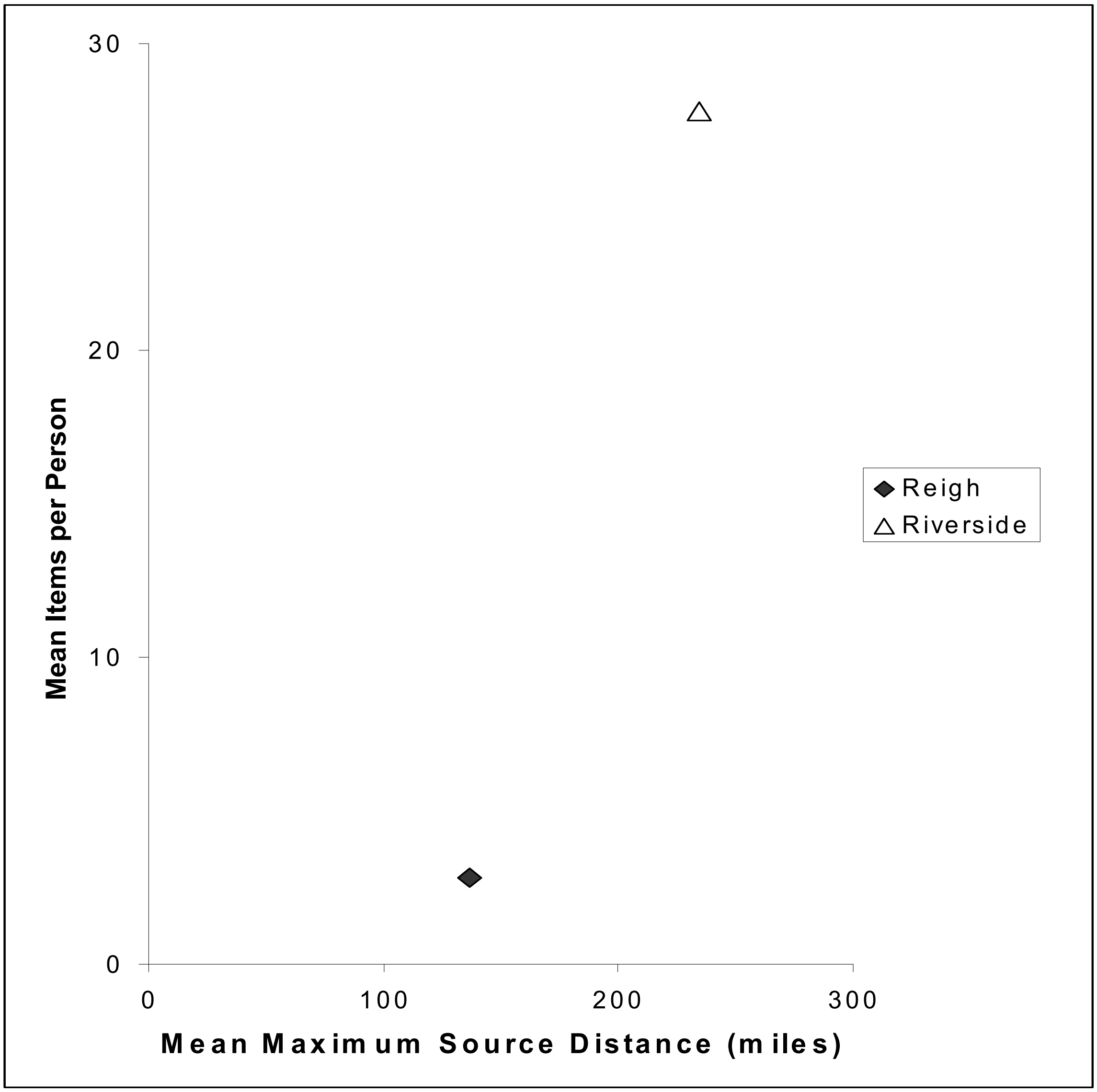


Figure 5.7. The average number of goods per person, plotted against the average source distance for those good, Reigh and Riverside sites.

Figure 5.8 establishes that the frequency of non-local and formalized Wyandotte chert bifaces follows a power-law distribution ($r^2 = 0.99$), showing that a limited number of individuals in this society had access to the exchange networks that provided these items. Copper beads also similarly follow a power law distribution ($r^2 = 0.92$), suggesting that they also are materials for which access is restricted. In contrast, grave goods of local origin follow a log-normal distribution ($r^2 = 0.95$), indicating the open access to non-exotic items in this community.

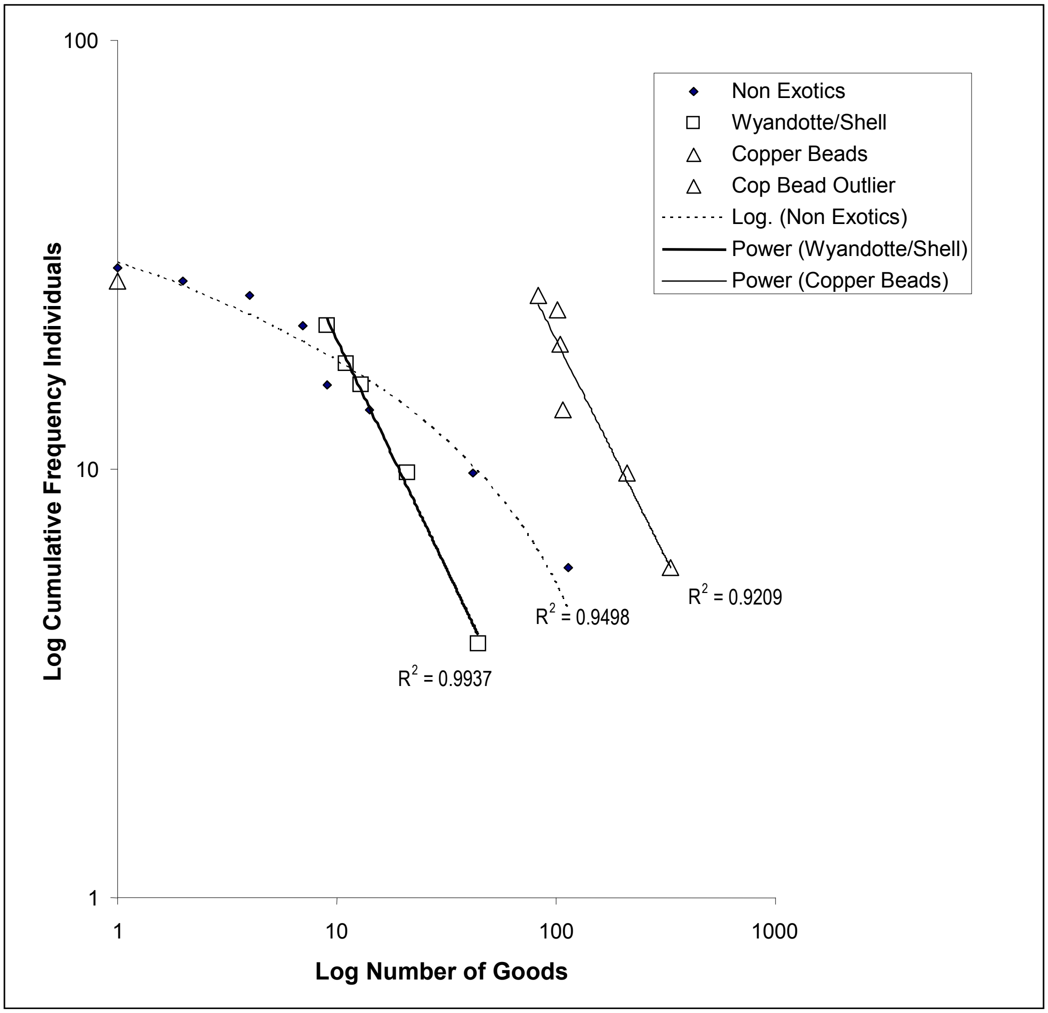


Figure 5.8. The distribution of exotic Wyandotte bifaces, copper beads, and non-exotic grave goods in the Riverside mortuary population.

The prediction from Chapter Two is again supported. Only a few individuals in the Riverside community have access to the direct benefits of exchange networks, while the rest of the community must rely on those individuals for access to less direct, or secondary, benefits. In fact, nearly 47 percent of all grave goods—comprised mostly of copper beads and Wyandotte chert bifaces—are associated with less than 10 percent of the mortuary population. Riverside represents a community in which the development of "haves" and "have-nots" has already occurred, and in which copper beads and Wyandotte chert bifaces are symbols associated in some way with individuals who have social positions as brokers to other communities.

3. Standardization and Symbolism

Large bipointed bifaces (Figure 5.1) are widely distributed throughout the Midcontinent during the Late Archaic (Didier 1967). Typically found in caches and mortuary contexts, these bifaces are often made from blue-grey chert identified as Wyandotte chert. Their wide distribution, uniform manufacturing methods and materials, and morphological similarity have suggested that these artifacts functioned within a regional system of shared symbolism and ritual (Didier 1967; Hill 2007; Krakker 1997; Morrow et al. 1992).

Several sets of these bifaces were recovered from mortuary features at the Riverside site, while morphologically different large bifaces were similarly interred with burials at the Reigh site (Figure 5.9). These bifaces allow for a comparison of materials and metrics to address questions regarding the development of symbolism and specialization during the Late Archaic. Did bifaces at Reigh and Riverside convey meaning among local populations only, or were they used to convey standardized information over regional scales and among disparate populations?

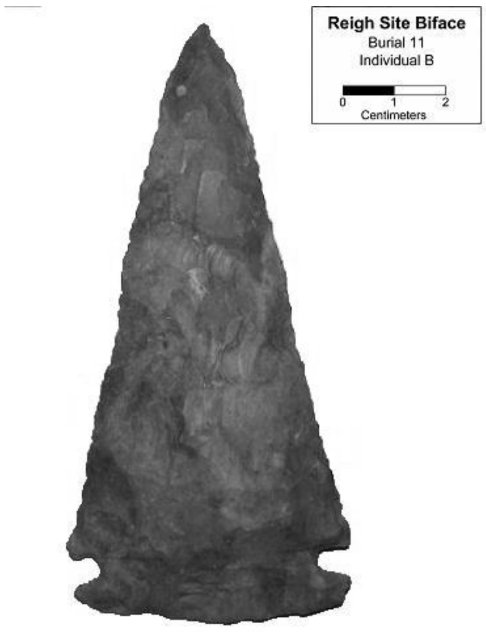


Figure 5.9. Reigh site mortuary biface.

Metrics and raw material characteristics are used here to answer this question. If bifaces function largely at local scales, they are more likely to be manufactured locally and to have greater variability in metrics since agents would already understand the meaning and value of these artifacts and they may be produced by multiple manufacturers. If functioning at broad regional and local scales, participating agents will have varying understandings of the meaning and value of these artifacts. Under these conditions, the standardization of metrics and raw material of manufacture would enhance the ability of these materials to convey reliable information over large distances and between diverse societies (e.g., Wobst 1977). The appearance of standardization in metrics and materials would then suggest the development of regional social interaction through shared symbolism.

The principle differences between these two hypotheses fall into the two categories of 1) raw material types, and 2) variability in metric attributes. Eighty five bifaces from Riverside were examined, and then compared to six large mortuary bifaces from Reigh. Metric attributes and raw materials characteristics were recorded for each biface for use in further analysis.

Of the 85 Riverside bifaces, all but three (96.4 percent) were identified as being manufactured from Wyandotte chert. Two of the exceptions were large stemmed bifaces, or Adena points, made of Burlington chert—again a non-local lithic material from the mid-Mississippi Valley. The third exception is another Adena point of unidentified chert that has characteristics somewhat consistent with Wyandotte.

Upon examination, these Wyandotte bifaces are remarkably consistent in their method of manufacture from chert nodules. Over two-thirds of these artifacts show purposeful use of nodular characteristics, including centering the biface with regard to circular banding in the material and deliberately leaving cortex at one or both tips of the biface. These characteristics stem from a relatively standardized production method that attempts to not only utilize the entire length of the nodule but also to visibly *demonstrate* that method and the nodular origin of the biface. Such a production method is quite wasteful and likely to generate large quantities of debitage, yet few pieces of Wyandotte chert other than these bifaces are present at Riverside.

The Reigh bifaces are also largely consistent in raw materials, in this case five of the six (83.3 percent) were manufactured from Galena chert, while the sixth was manufactured from Prairie du Chien chert. Both of these cherts occur in bedrock outcrops, streambeds, and shorelines within 100 to 150 miles of the site, and are relatively common raw materials on Archaic sites in the area. While the Reigh site bifaces clearly show adherence to an ideal form, they are more variable than the Riverside artifacts. Further, many of them show reworking and beveling, characteristics largely absent from the Riverside bifaces.

Table 5.3. Individual and material associations for the Riverside and Reigh bifaces used in the analysis.

Site	Feature	Individuals Associated With Bifaces	Associated Materials	Other Individuals	Dates (uncal)
Riverside	F27	1 young adult female	8 Wyandotte bifaces 2 marine shell beads	None	2190 ± 140 BP 2850 ± 50 BP
	F29	1 adult female, 1 infant	43 Wyandotte bifaces 210+ copper beads	None	2960 ± 50 BP
	F30	2 adults, unknown sex	13 Wyandotte bifaces	None	2080 ± 140 BP
	F31	1 child	12 Wyandotte bifaces 1 Burlington adena point	1 old adult male 1 adult female 2 adults, unknown sex	2460 ± 140 BP 2710 ± 50 BP
	F37	1 middle adult female 1 infant	6 Wyandotte bifaces 2 adena points 108+ copper beads	1 young adult female	2380 ± 50 BP 1949 ± 130 BP
Reigh	B11	1 young adult male	1 large Galena biface 1 notched bone tube 1 owl leg 1 antler handle	1 young adult male 1 adult unknown	None
	B23	1 young adult male	1 large Galena chert biface 1 conical copper point 1 elk-antler axe handle 2 bone tubes	None	None
	B25	1 middle adult female	1 large Galena chert biface	1 adol. unknown. sex	None
	B26	1young adult female	1 large PDC chert biface 1 conical copper point	1 young adult female	4490 ± 40 BP

Length, width, and thickness values were recorded for each of the eighty five bifaces from features 27 (*n=8*), 29 (*n=43*), 30 (*n=13*), 31 (*n=13*), and 37 (n=8) at Riverside, and the six bifaces from burials 11, 23, 25, 26 and surface contexts at Reigh (see Appendix III and Appendix IV). Details of these features are presented in Table 5.3 for context. These data formed the basis for statistical analysis comparing variability within and between features at Riverside, and between the Riverside bifaces and those from Reigh.

Before comparing the Riverside bifaces with those from Reigh, variability within the Riverside assemblage must first be explored. After first gaining a better understanding of the variability within the several sets of bifaces at Riverside, they will then be compared with the much smaller and earlier assemblage from Reigh.

The Riverside bifaces tend to be consistent in width and thickness, falling between 30 to 50 millimeters in width and 7 to 14 millimeters in thickness (Figure 5.10a). A tendency to cluster by feature is noted, but not statistically demonstrable with these data. However, by comparing length and width variables, features 27, 30, and 31 discretely cluster, feature 37 clusters less so partially because of the inclusion of the two Adena points, and feature 29 exhibits greater variability in biface length (Figure 5.10b). This observation was explored further using ANOVA comparing length, width, and thickness distributions from each feature. All three variables were found to differ significantly from one feature to the next (Length $F=35.091, df=4, p<.000$; Width $F=35.088, df=4, p<.000$; Thickness $F=5.379, df=4, p<.001$), indicating that each feature forms a more-or-less homogeneous cluster centered upon its own unique mean.

Four of the five features at Riverside demonstrate remarkable internal homogeneity in biface metric attributes, while the remaining feature, F29, exhibits greater variability. This perhaps results from multiple biface sets being placed with the two individuals buried in this grave. A Ward's method cluster analysis and discriminant function analysis, in which each feature except F29 was successfully grouped and reclassified, demonstrated that biface length accounted for 99.8 percent of the variance between features. Accordingly, F29 biface lengths were graphed, resulting in the three distinct nodes shown in Figure 5.11. Nodes occur at lengths of 134, 152, and 180 millimeters, suggesting that perhaps as many as three sets of bifaces are represented among the 43 bifaces in F29.

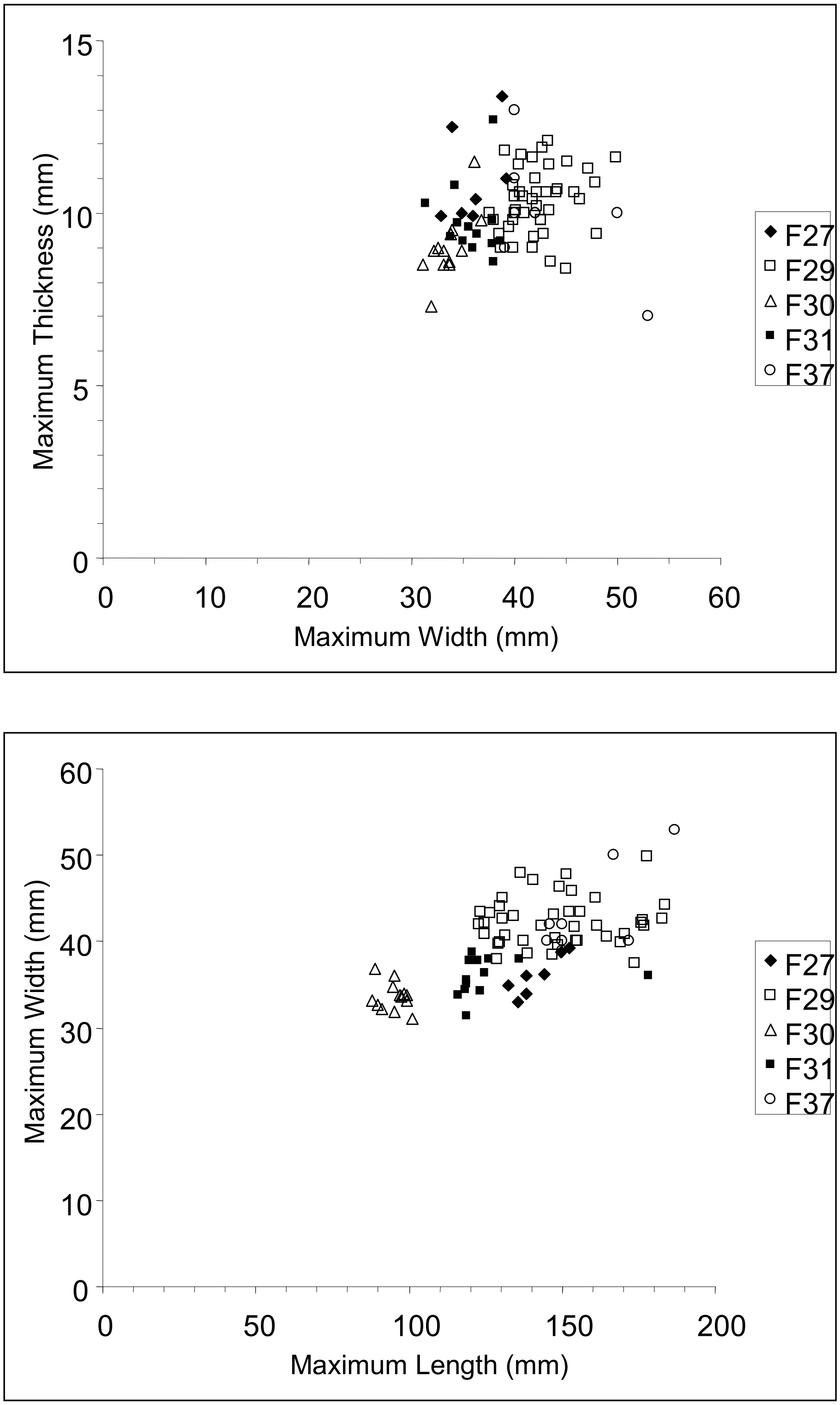


Figure 5.10. Scatterplots comparing a) width versus thickness, and b) length versus width, of Riverside site mortuary bifaces. While bifaces cluster strongly in width and thickness, slight differences in length separate the bifaces from each feature into relatively discrete sets.

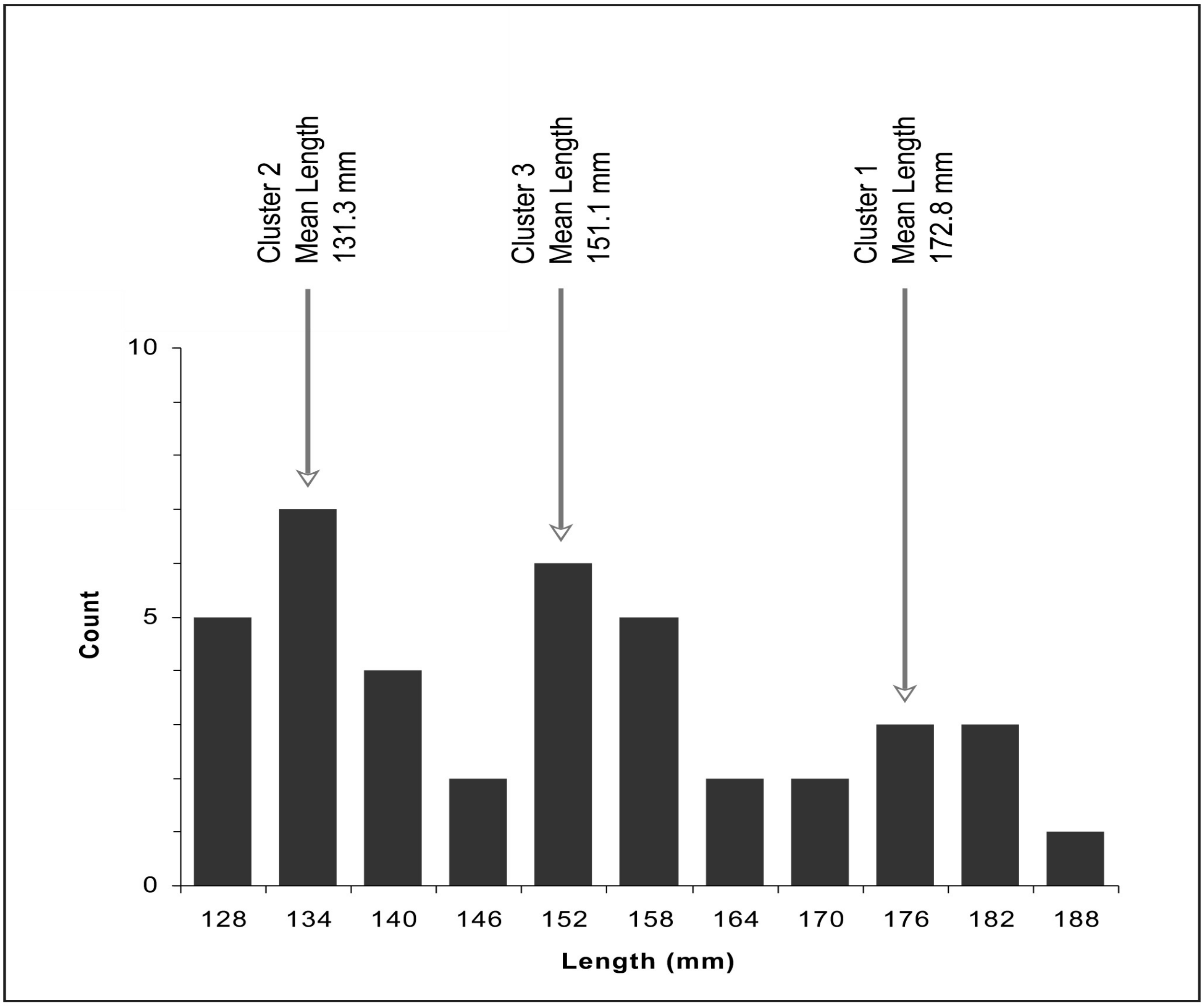


Figure 5.11. Histogram of biface length, demonstrating the multimodal nature of the F29 bifaces. The results of Ward's method cluster analysis,shown in Figure 5.12 and in which three distinct clusters were identified, are superimposed above the histogram.

Ward's method cluster analysis and Discriminant Function analysis were performed on the F29 data. A three cluster solution was found to be the best (Figure 5.12), and a single factor, associated with length, accounted for 99.2 percent of the variance. Reclassification of the three cluster solution succeeded in correctly reassigning 97.6`percent of the cases. The mean length for each cluster is 131.3 mm, 151.1 mm, and 172.8 mm, figures that closely match the three modal values shown in Figure 5.11.

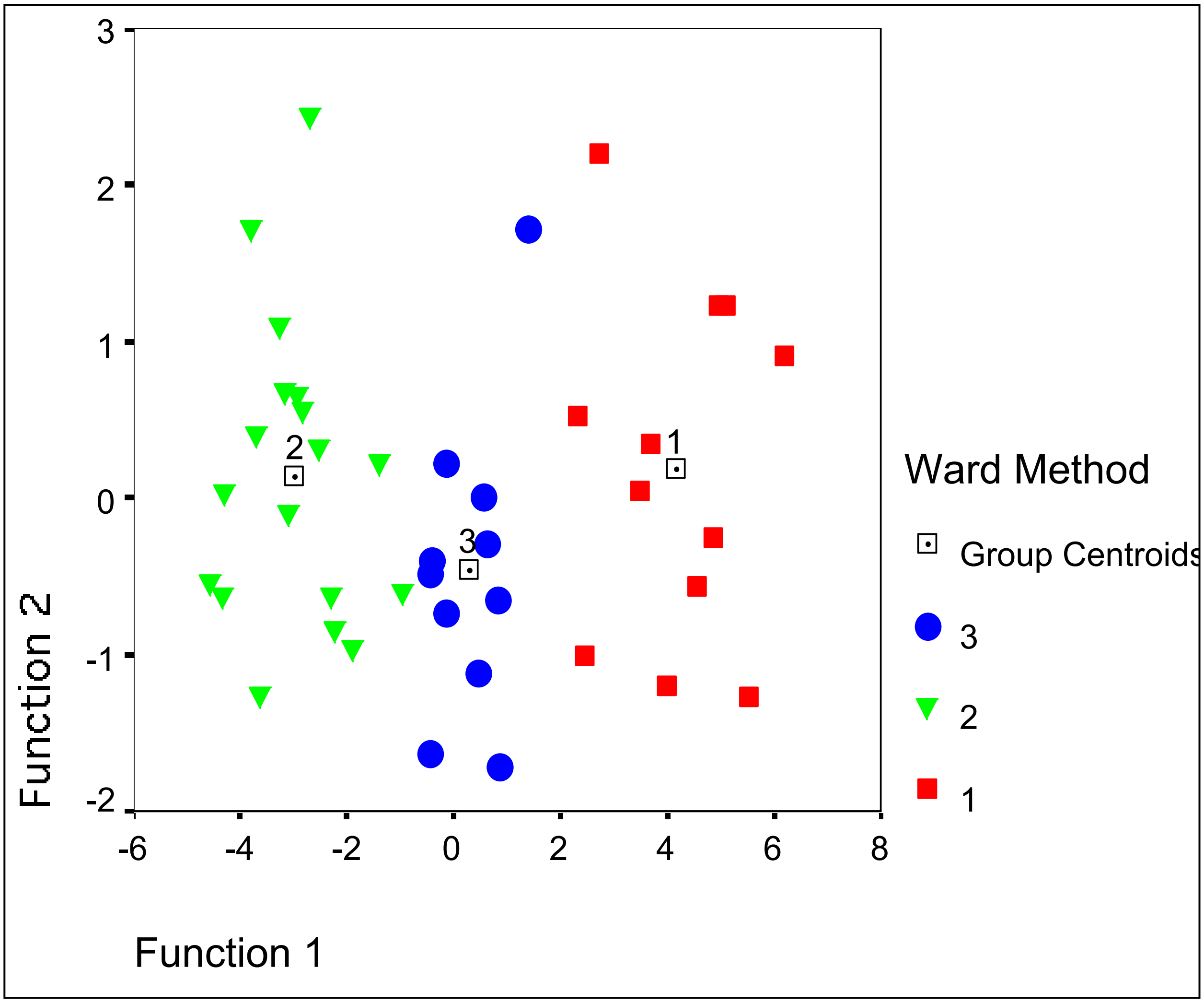


Figure 5.12. Discriminant function plot of Feature 29 mortuary bifaces, demonstrating three groups of discriminated largely by Function 1. Reclassification of these three clusters was successful for 97.6 percent of the cases, and the three clusters here correspond with the three length nodes shown in Figure 5.11.

This analysis suggests that Riverside bifaces functioned as sets, that each feature represented in this analysis contained one or more sets, that each set is internally homogenous with regard to metrics and raw materials, and that overall the Riverside bifaces are remarkably similar and share a single manufacturing method, raw material type, and overall morphology.

But are they truly standardized? Coefficients of variation can be calculated to determine the degree of variation within each set. Human perception limits the degree to which differences between individual items can be identified, and thus limits the degree to which items produced to fit a standardized model will actually conform to that model. Research has demonstrated that variations of length less than 3 percent are not perceived through visual comparison (e.g., Eerkins and Bettinger 2001). Coefficients of variation (CV) can measure this variation within sets of items to assign a numeric value to the degree of variability in a particular population. CV, or the sample standard deviation divided by the sample mean, is often multiplied by 100 to produce a percentage of variation. Eerkins and Bettinger (2001) have demonstrated that the 3 percent variation in length corresponds to CV values of 1.7. In other words, a craftsman judging the match between bifaces is not able to produce a closer fit than CV values of 1.7. Conversely, random production yields CV values of 57.7 (Eerkins and Bettinger 2001). These two figures are then the two ends of a scale by which we can measure standardization. Figures close to CV values of 1.7 are highly standardized, those close to 57.7 are random.

Values were then calculated for each biface set to compare Riverside biface variability to that discussed by Eerkins and Bettinger (2001) and with other sets of bifaces, including projectile points from contemporary sites in the Upper Midwest and the mortuary bifaces from Reigh. Projectile points were chosen for this comparison since they are more likely to be manufactured by multiple individuals for personal use, in contrast with the posited symbolic use of the mortuary bifaces. Only sites with multiple complete projectile points were used in the analysis, with CV values determined for each separate assemblage. Figure 5.13 displays the results, and demonstrates the extremely limited range of variability for the Riverside bifaces whose CV values fall between 2.1 and 7.0—compared to projectile point values that fall between 5.3 and

44.3. Riverside mortuary bifaces fall close to the highly specialized end of the spectrum, while projectile points display a non-overlapping distribution which clusters closer to the middle of the CV spectrum.

Reigh bifaces fall within the range of projectile point CVs. These bifaces differ not only morphologically, but in their context of use and deposition as well. While mortuary bifaces at Riverside appear to have been manufactured and buried as sets, the Reigh bifaces were buried singly. Length and width strongly covary ($r^2 = 0.98$), and no clustering was apparent in the metric data (Figure 5.14). The Reigh bifaces do not appear to be the product of specialized production.

Table 5.4 summarizes the key differences between the late Middle Archaic mortuary bifaces at Reigh and the later Late Archaic mortuary bifaces at Riverside. Riverside bifaces were manufactured using a process that employed Wyandotte chert from the Ohio Valley, and bifaces were deliberately produced to display the production method by retaining cortex at one or both ends and centering any banding in the chert at the midpoint of the blade. Furthermore, bifaces were likely produced as homogenous sets that are internally consistent with regard to length, width, and thickness. Since this manufacturing process is likely to produce large amount of debitage and given the apparent absence of this debitage in the Riverside site and other nearby Late Archaic sites (e.g., Hill 2006; Moffat and Speth 1999), production of these bifaces appears to have taken place elsewhere—probably in the Ohio Valley nearer the source of Wyandotte chert.

Reigh bifaces were manufactured as individual artifacts from locally available materials, likely by local craftsmen. While conforming to an idealized morphology, they nonetheless are highly variable in metric attributes and display evidence of having been used and maintained through resharpening—unlike Riverside. There is no apparent attempt to standardize metrics and display the production methods involved in their manufacture.

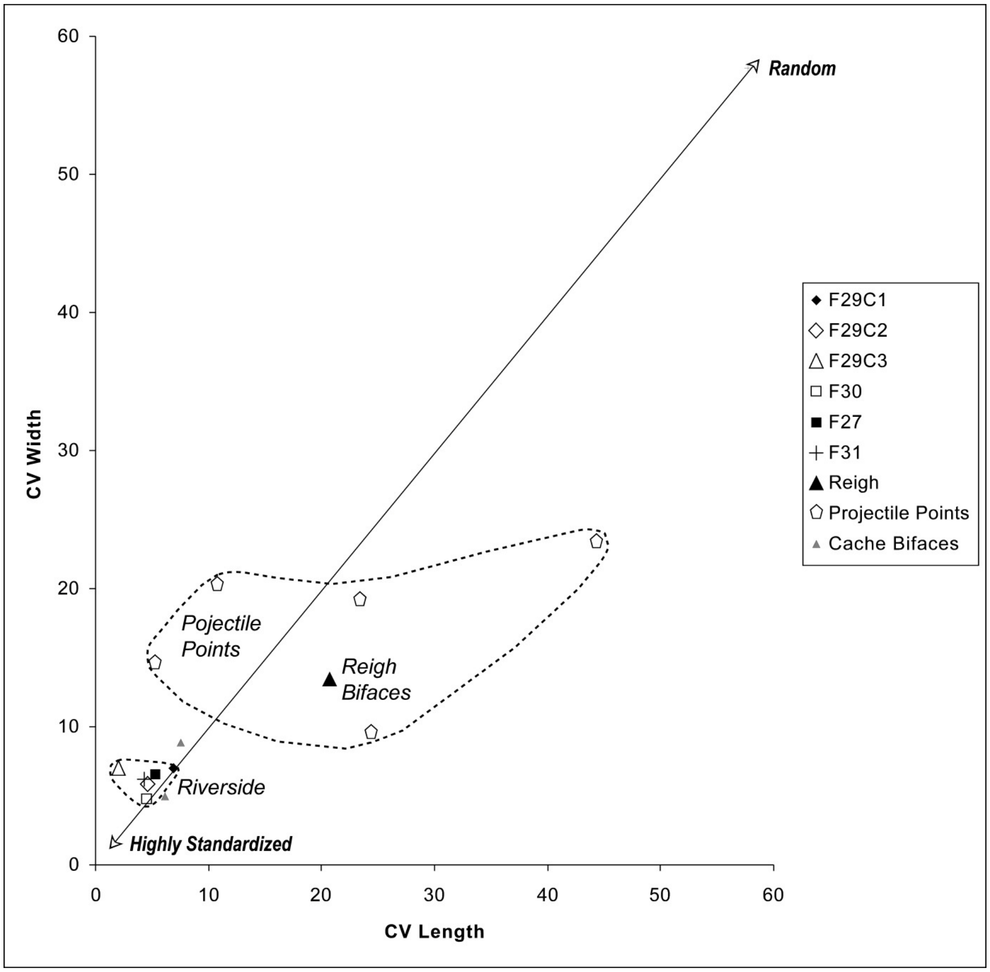


Figure 5.13. Comparison of variability in the Riverside biface assemblage (by feature set) with variability in the Reigh mortuary bifaces and also with contemporary projectile points. The scale from Highly Standardized to Random is based on Eerkins and Bettinger 2001.

These data conform with the development of a regionally consistent symbolism during the Late Archaic. The late Middle Archaic Reigh bifaces best fit a model of local production, use, and meaning. On the other hand, the later Riverside materials are the result of a semi-specialized production process, and are homogenous with regard to production methods, metrics,

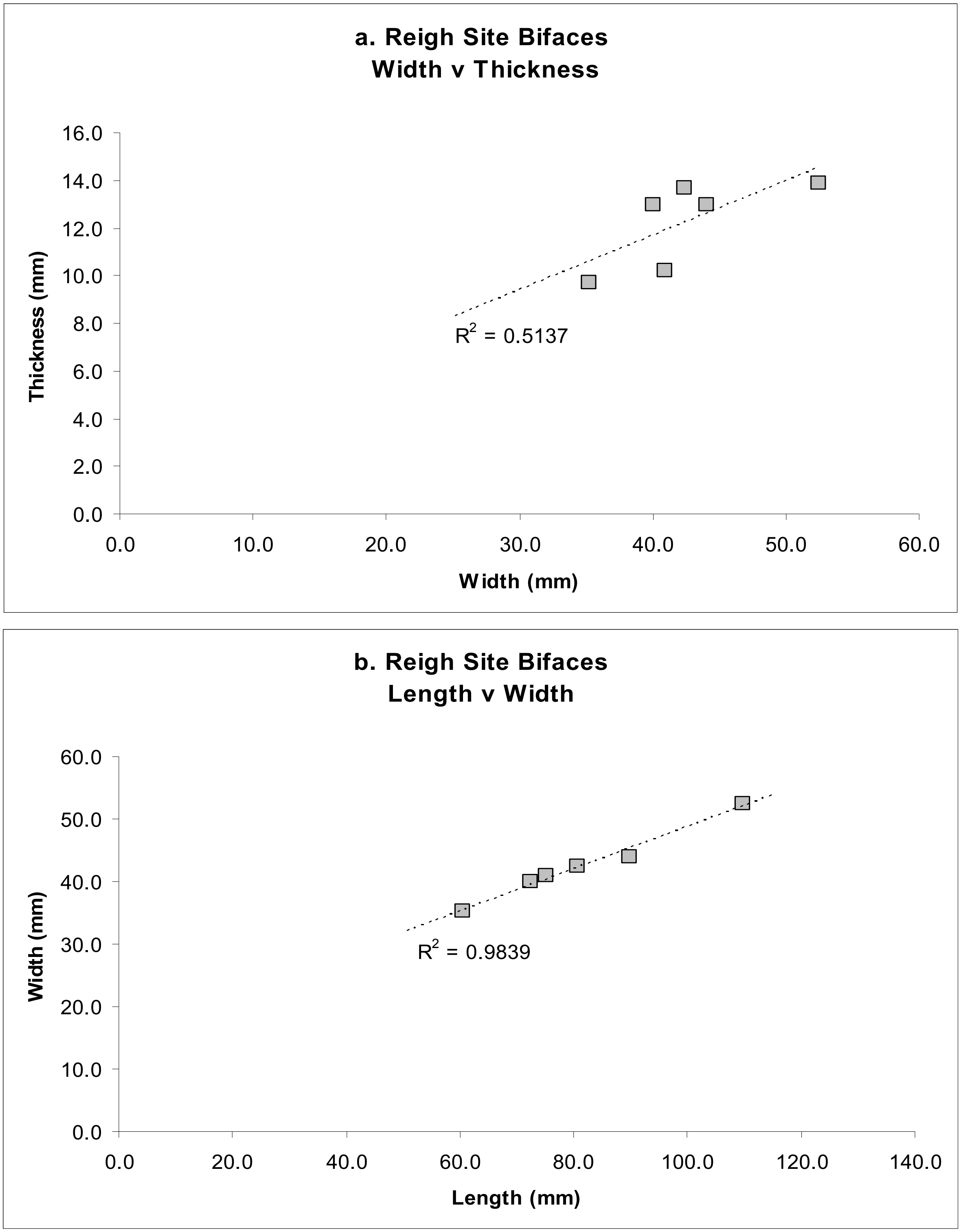


Figure 5.14. Metric attributes of Reigh bifaces; a) width versus thickness, and b) length versus width. Unlike Riverside, the Reigh bifaces show less clustering, and length strongly covaries with width.

and raw material attributes in order to convey consistent and recognizable symbolism across large geographical and social spaces. Such standardized materials, with the conspicuous display of attributes, also decrease the risk inherent in inter-community interaction. Through this clear display, exchange participants can be certain of the authenticity of the meaning, value, and quality of the transaction inherent in the interaction (e.g., Wobst 1977).

Table 5.4. A comparison of late Middle Archaic and Late Archaic biface attributes from the Reigh and Riverside sites.

	Raw Material	**Production Method**	**Variability**	**Depositional Context**
Riverside	Non local	Standardized	Low	Uniform Sets
Reigh	Local	Non standardized	High	Single bifaces

4. Intergroup Conflict

While the potential for conflict is minimized through such standardization, some potential remains, particularly in the case of failed reciprocity and the corresponding degradation of trust. Does intergroup conflict appear or increase during the Late Archaic as predicted in Chapter Two? There are several methods useful to studying this question, principally examining human remains for signs of trauma, looking at population demographics to examine trends associated with life histories and death, and finding the actual remains of warfare—such as sites containing the remains of battles or massacres. The latter two are utilized here.

Published sources (Binford 1972; Hruska 1967; Papworth 1967; Pfeiffer 1977) were consulted to gather demographic information on mortuary populations of these three sites. Susan Pfeiffer's (1977) skeletal analysis of Great Lakes Archaic populations was particularly useful, as was Binford's (1972) analysis of Feature 6 at the Riverside site. Individuals from all three sites had all been sexed and aged during previous analyses. Pfeiffer (1977) reanalyzed the mortuary populations from these sites, providing consistent and comparable demographic data.

Demographic data from Oconto, Reigh, and Riverside were compared to investigate changing life histories in these Middle Archaic, early Late Archaic, and later Late Archaic populations. Age and sex determinations were used to examine mortuary population characteristics. Age categories and sex determinations are the same as those used by Pfeiffer (1977) in her comprehensive examination of Archaic populations in the Great Lakes. Age categories include Young Adult (< ca. 35 years), Middle Adult (ca. 35 > 55 years), and Old Adult (> ca. 55 years). Subadult and infant categories were also present in these populations, but were excluded from this analysis due to the inability to sex most of these individuals.

At the Middle Archaic Oconto site, a total of 37 adults (including cremations) were identified in the mortuary population (Pfeiffer 1977:82-93; Ritzenthaler and Wittry 1957). Of these, 70 percent are assignable to age and sex categories, the remainder are unidentified adult remains. Male and females are represented roughly equally, with a 0.86:1 male to female ratio. No individuals were assigned to the Old Adult category. Mortality seems to have been equal for males and females, with most individuals were assigned to the Young Adult category (Figure 5.15a). Pfeiffer identified six cases of trauma in the Oconto population, often featuring injury to the anterior tibia which she tentatively attributed to the use of woodworking tools rather than warfare (1977:177-180).

A similar pattern appears at Reigh, where Pfeiffer (1977) identified 26 adults in the population. Of those, 84.6 percent were assignable to both age and sex categories for analysis. As at Oconto, the total adult population featured slightly greater numbers of females than males, with a 0.79:1 male to female ratio. Once again, mortality seems to equally affect males and females, with approximately 80 percent of both males and females assignable to the Young Adult category. No individuals were assigned to the category of Old Adult (Figure 5.15b). Pfeiffer identified only three cases of trauma in this population, including a healed mandible fracture and a healed fracture of the humerus (1977:173-175).

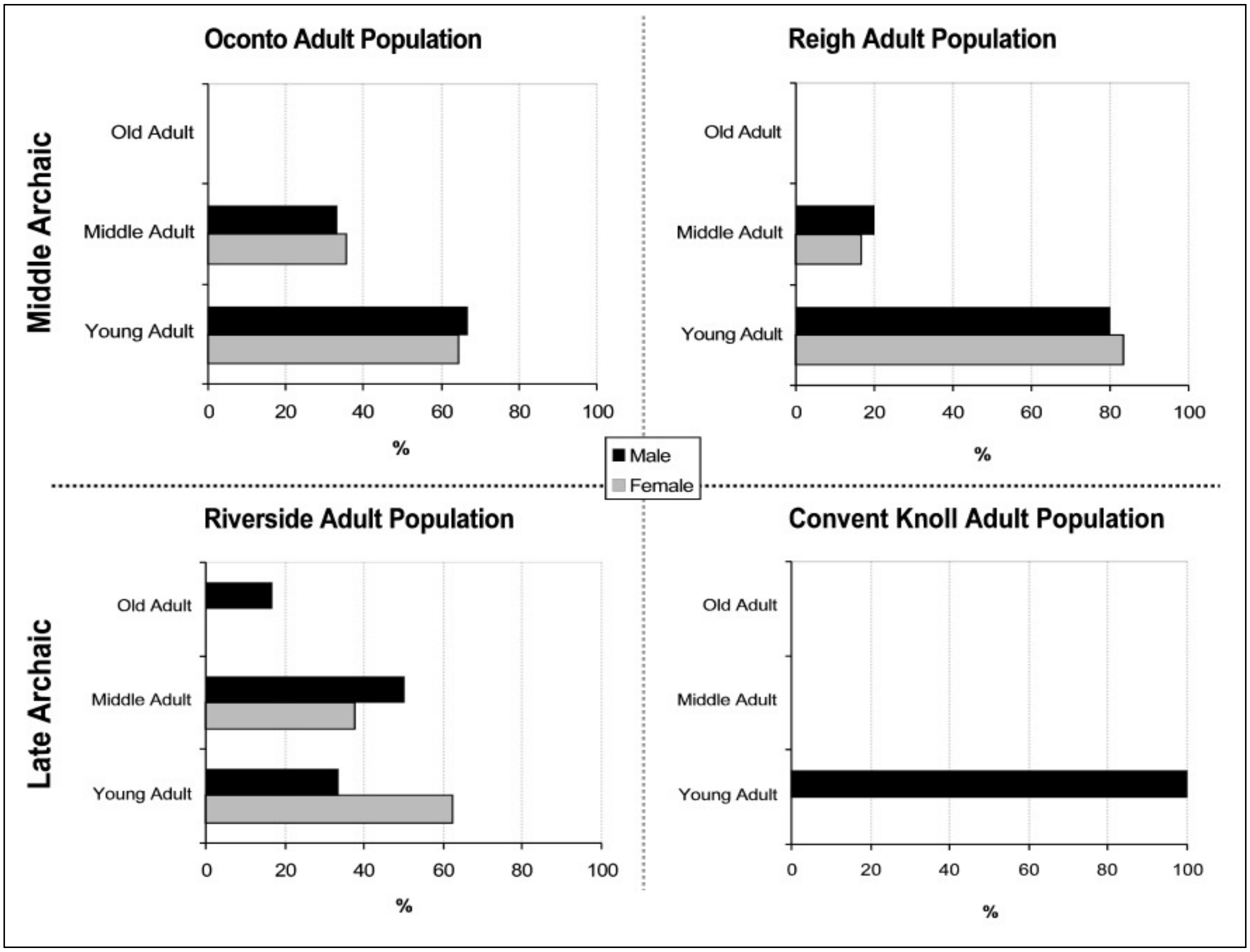


Figure 5.15. Demographics of the adult mortuary populations from Oconto, Reigh, Riverside, and Convent Knoll.

A different picture emerges from the Riverside data. Previous analysis by Pleger (1998, 2000) demonstrated that adult males are significantly underrepresented at Riverside, and adolescent males are absent. Adult and adolescent females comprise the majority of the identifiable population. Males and females are disproportionaly represented in each age category (Figure 5.15c) with over 60 percent of the females assigned to the Young Adult category but only 33 percent of the males are Young Adults. Males only outnumber females in the Middle and Old Adult categories. Pfeiffer's analysis of a portion of the Riverside population did not identify any cases of trauma (1977:170-171), yet several cases of embedded projectile points and trauma were noted by Hruska (1967:208-213; 217-219) in his report on the site.

The discrepancy between male and female mortality in the Young Adult category raises the possibility of either increased mortality in females or some factor affecting the burial of males. The female demographics do not dramatically change from Middle Archaic to Late Archaic (Figure 5.15), suggesting that this results from a differential treatment of Young Adult males at Riverside. Correlation coefficients comparing males to males and females to females from each site (Table 5.5) demonstrates that it is males at Riverside, not the females, that are at odds with the earlier sites. Female demographics remain consistent from the Middle Archaic through the later Late Archaic while the interment of young adult males decreases sharply.

One possible explanation for this is warfare in which individuals are killed elsewhere and, for some reason, not returned to Riverside for burial (Figure 5.15d). Dramatic support for this comes from a contemporary site in southeast Wisconsin called Convent Knoll (Overstreet 1980). A total of eight individuals were buried as the aftermath of what the investigator believed to be a single violent event. A young adult male was buried in one feature with red ocher staining, a projectile point embedded in a lumbar vertebra, and grave furniture including ceremonial bifacial blade, copper celt, and shell beads. A second nearby burial contained the remains of a young child accompanied by grave furniture that included a white chert ceremonial biface, a large well-made hafted biface, a copper awl, and several shell beads. Another burial feature, isolated some

28 meters north of the other individual interments, contained the mixed burials of six adult males. These individuals were haphazardly dumped in the pit after being killed and mutilated. That violent trauma was involved is not questioned as these individuals had suffered severe perimortem wounds, decapitation and dismemberment (Overstreet 1980:60-75).

Table 5.5. Pearson's R values comparing male and female demographics from the Middle Archaic Oconto and Reigh sites and the Late Archaic Riverside site. Correlations between female populations at all three sites are high, while Riverside males demonstrate lower correlations.

Males	*Riverside*	*Reigh*	*Oconto*
Riverside	1.000	0.240	0.500
Reigh	0.240	1.000	0.961
Oconto	0.500	0.961	1.000

Females	*Riverside*	*Reigh*	*Oconto*
Riverside	1.000	0.901	0.974
Reigh	0.901	1.000	0.976
Oconto	0.974	0.976	1.000

All the adults at Convent Knoll were male, and consistent with young to late young adult age categories. However, of the seven adults represented at Convent Knoll, dismemberment only allowed for four to be reliably aged. Of these, all were young males between 25 and 35 years of age—the same age category shown to be underrepresented at Riverside (Figure 5.15c).

The absence of young adult males in the Riverside cemetery may thus be a result of increased interaction with neighboring social groups, reflected at times in occasional inter-group warfare. Violent trauma noted at Riverside by Hruska (1967), the relative lack of violent trauma at Oconto and Reigh, the absence of young adult males at Riverside, and the mass burial of violently killed and dismembered young males at Convent Knoll all combine to suggest an increase in conflict and warfare during the later Late Archaic.

Fitness Benefits

In Chapter Two it was proposed that exchange is an evolutionary stable strategy which provides benefits to participants in the form of increased fitness. Does greater fitness accrue to those individuals with access to exchange networks, as the hypothesis predicts? This question poses a potential tautological trap in the temptation to use exotic goods as an indicator of status, then showing the higher status of those individuals with non-local goods. To avoid this problem, two approaches are used to address the question of exchange benefits. First, are those individuals who have exchange goods interred with more grave goods than those lacking direct access to exchange networks? Second, can greater reproductive fitness be demonstrated through a correlation of exotic goods with greater numbers of individuals per grave feature? As noted earlier, several features contain multiple individuals, often appearing to represent mothers, wives, and children within a single family or kin group. By using the numbers of individuals per feature as a proxy of reproductive success, can it be demonstrated that reproductive success is correlated with access to materials featured in exchange networks?

Objects such as leather and bark fragments are excluded from this analysis due to incomplete and inaccurate data. Many are still encased in matrix from features removed as a block, and as a result have never been counted.

Those grave features with exotic bifaces and copper beads have an average of 106.7 items per feature (Table 5.6). Those lacking these items have an average of only 6.8 grave goods per feature. A *t*-test shows this difference to be significant (*t = 4.676, df = 37, two-tailed* *p=.000*), thus the presence of such items as exotic chert bifaces and copper beads suggests differential access to resources in which those connected to exchange networks have greater numbers of goods than others. Access to resources is a characteristic that research shows to be positively correlated with reproductive fitness in modern populations.

Table 5.6. Comparison of total grave goods in features with and without exotics and copper beads.

Features with exotic chert bifaces and copper beads

Feature/Burial	Total Items
3	129
13	84
14S	104
17	336
27	15
29	253
30	14
31a	13
37ab	117
43	2
Mean per feature	106.70

Features without exotic chert bifaces or copper beads

Feature/Burial	Total Items
4	2
6S	43
7	0
9	1
10S	2
19	0
21	9
22	0
25	0
26	0
28	0
31bc	0
32a	2
32bcd	0
35	7
36	1
37c	5
38	0
39	0
41	4
44	0
45	2
52	0
56	5
63	114
68	0
69	0
74	0
80	0
Mean per feature	6.79

Table 5.7. Rotated component matrix comparing Riverside grave goods with the number, sex, and age of individuals interred per feature. Component 2, accounting for 13.769% of the variance, shows the positive association between the number of individuals per feature and the Wyandotte chert bifaces obtained through exchange networks.

	Components						
Category	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Copper Celt	0.027	-0.026	-0.154	0.817	0.001	-0.031	-0.230
Copper Awl	0.342	-0.014	0.745	-0.034	0.285	-0.173	-0.053
Copper Crescent	-0.055	-0.066	0.910	0.022	-0.112	0.059	-0.009
Copper Point	0.817	0.007	0.440	-0.018	-0.144	0.096	-0.003
Exotic Chert Bifaces	0.013	0.841	-0.046	0.079	0.204	-0.111	0.013
Burned Blades	-0.025	0.910	-0.013	-0.032	-0.041	0.053	0.022
Mortuary Bifaces (F63)	-0.047	0.007	-0.083	-0.045	-0.082	-0.048	0.865
Hafted Bifaces	0.810	-0.092	-0.162	0.018	0.184	0.026	-0.054
Shell Beads	0.057	0.044	0.038	-0.219	0.735	-0.307	-0.072
Beaver Teeth	0.925	0.018	0.101	-0.009	-0.082	0.043	0.016
Number Interred	-0.197	0.532	-0.080	0.057	-0.035	0.629	-0.210
Male	0.346	-0.208	0.004	-0.208	-0.005	0.753	0.031
Female	-0.139	0.209	-0.043	0.185	0.747	0.362	-0.076
Juvenile	-0.109	0.209	0.228	0.717	-0.088	-0.146	0.397
Adult Unknown	-0.214	0.238	-0.226	-0.482	-0.489	-0.067	-0.447
Eigenvalue	3.008	2.065	1.891	1.446	1.372	1.145	1.001
Percent Variance	20.052	13.769	12.603	9.643	9.147	7.632	6.675

Does this greater access to resources indicate that exchange networks confer a reproductive advantage on participants as the hypothesis predicts? Principal components analysis with Varimax rotation (SPSS 10) was used to examine the relationships between categories of grave goods and the number, sex, and age of the individuals interred in each feature at Riverside. Seven components were extracted, accounting for 79.5 percent of the variance (Table 5.7). Component 1, accounting for 20.05 percent of the variance, consists of copper points, hafted bifaces and beaver teeth and is most closely associated with adult males. Component 2, accounting for 13.8 percent of the variance, consists of a positive correlation between burned and unburned exotic chert bifaces, standardized exchange artifacts manufactured from Wyandotte chert, and the number of individuals interred per feature. This component also exhibits a positive correlation with adult females and juveniles. This principal components analysis demonstrates that a positive association exists between standardized materials obtained through exchange and the number of individuals per mortuary feature, suggesting that access to exchange networks is associated with increased reproductive fitness.

Summary

At the outset of this chapter, it was proposed that the regional interaction that characterizes later Middle Woodland societies in the midcontinent first begins to develop in the Late Archaic. Certainly widespread exchange of material goods began at this time, but additional indicators of information exchange and sociopolitical relations were necessary to confirm that midcontinental regional systems and social networks begin at this time.

Using data from the Oconto, Reigh, and Riverside sites in the Lake Michigan region of Wisconsin and upper Michigan, this study examined four dimensions of social interactions; 1) changes of frequency and scale in the exchange of material goods, 2) the development of differential access to exchange benefits, 3) the appearance of standardization in exchange materials to foster trust and effectively transmit ideas and meaning over large social distances, and 4) increasing conflict between communities when trust is lost and interaction becomes more negative.

Table 5.8 summarizes the results. While exotic materials goods are present at the earlier Oconto and Reigh sites, it is not until the Late Archaic that a significant expansion in the frequency of long distance exchange occurs. At Reigh, only 1.4 percent of the grave goods originated from sources greater than 200 miles distant, while at Riverside this figure had increased nearly tenfold to 11.8 percent. The majority of these distant materials at Riverside consisted of bifaces manufactured of Wyondotte chert from the Ohio Valley.

Riverside has clearly passed any cost/benefit thresholds that may have limited the role of exchange in earlier communities. Integrated exchange systems link Riverside with the Ohio Valley and beyond by around 3000 BP. Within this community, access to these networks is limited to a few individuals, while others must rely on those with direct access for secondary benefits—thus making those with direct access *irreplaceable* in the Riverside community.

Table 5.8. A comparison of the dimensions of regional social interaction for the Middle Archaic Oconto, late Middle Archaic Reigh, and Late Archaic Riverside sites.

Site	***Exchange of Exotics***	***Differential Access to Exchange Benefits***	***Scale of Information Transmission and Symbolism***	***Conflict***
MA Oconto	-	-	-	Not Noted
Late MA Reigh	Limited	Limited	Local	Not Noted
LA Riverside	Expanding	Yes	Regional	Present

Regionally shared symbolism is also more evident at Riverside than at the earlier Reigh site. Certainly Reigh's sandal-sole gorget suggests the early origins of regional symbolism and interaction, but at Riverside such symbolism is well established in the form of mortuary bifaces. Both Reigh and Riverside feature large bifaces as mortuary furniture, but the Reigh bifaces are highly variable, less numerous, made from locally available materials, and function singly. These bifaces functioned in part to convey socially important information to local populations. In contrast, the Riverside bifaces are manufactured non-locally of chert from the Ohio Valley, conspicuously use materials and manufacturing techniques to display their source, are highly consistent in metrics, materials and workmanship, and functioned as sets. These later bifaces were standardized to convey information over long distances and among diverse populations.

Sociopolitical relations occur along a continuum ranging from trust and cooperation to distrust, conflict, and warfare. Examining mortuary populations at Oconto, Reigh, Riverside, and Convent Knoll demonstrates that conflict appears more prominently in the Late Archaic. The earlier sites of Oconto and Reigh exhibit similar demographic profiles, with males and females approximately equally represented in all age categories, and mortality being highest for both sexes in the young adult category. The later Riverside site indicates growing differences in mortality or interment for males and females. Female demographics match those of Oconto and Reigh, while males are significantly underrepresented—most prominently in the young adult category. That this is due, in part, from distant conflict and mortality of young males is supported by the Convent Knoll site.

These four dimensions of regional interaction consistently yield the same results: exchange of non-local materials increases, standardization of symbolism for regional information exchange develops, and sociopolitical relations as measured through warfare becomes dramatically apparent during the period between after 3000 BP in the western Great Lakes. The Late Archaic of the western Great Lakes can then be seen as a time of social reorganization from small-scale societies with largely local social interactions, to small-scale societies participating in with distant regional communities through standardized exchange and occasional conflict.

With this example, exchange networks in the Late Archaic can be viewed as emergent phenomenon that derive from the individual fitness enhancing behavior of a limited number of individuals. Unlike other models that rely on the conscious and deliberate actions of *aggrandizers* (e.g., Hayden 1995, 1997) or of *great men* (e.g., Godelier 1986), this hypothesis suggests that complex regional systems of interaction and shared symbolism may have more humble origins in the collective small-scale fitness enhancing behaviors of individuals for whom exchange networks serve to provide benefits and create relationships of trust. Similar arguments can be found in Bender's (1985) emphasis on exchange, social relations, and agency, as well as in Braun's (1986) peer-polity interaction explanation. However, the present model differs from these explanations in its emphasis on sets of evolved fitness enhancing behaviors that appear to be evolved traits in our species.

Thus, regional systems of exchange and interaction develop in the Late Archaic as a predictable outcome of the collective action of individuals seeking their own individual benefits. Standardization of exchange goods and development of shared symbolism and ideology emerge as the result of risk mitigation and collective effects to enhance the predictability of exchange benefits.

CHAPTER SIX

MATERIAL SYMBOLS AND SOCIAL EFFECTS OF EXCHANGE

The previous chapter demonstrated that exchange and social interactions expand during the Late Archaic; however, all exchange is not equal. Exchange of gifts can range from sharing food with kin to the use of elaborate gifts to create social bonds through marriage or obligation. Items used in exchange also carry varying meanings. To understand the nature of the relationships created and mediated through the exchange of material goods, it is necessary to develop an approximate understanding of the emic nature of meaning and value that those goods convey.

Gifting and exchange are frequently used in small-scale societies to create or maintain social cohesion, express respect, fulfill responsibilities, or to create new bonds through marriage or alliance. A quick review of the Human Relations Area Files for native North American societies shows that gifts were given to arrange marriages, to consummate marriages, to participants in ceremonies from the host, to the host from participants and guests at ceremonies, to neighbors and kin as signs of respect or to aid those in need, to broker peaceful relations with neighbors, to atone for murder, to purchase rights and bundles, to apprentice oneself to shamans or other specialists, and to avoid hostilities.

Marriage is a particularly important example, since it is an institution that creates new relationships not only between the bride and groom, but between their families as well. Marriages in many North American native societies were arranged by older family members through the giving of gifts. In the Great Lakes, the historic Ojibwa, Menominee, and Winnebago, as well as other central Algonquian and eastern Siouan groups, created these affinal relationships in the following way (Buffalohead 1983; Densmore 1929; Dunning 1959; Radin 1990; Skinner 1913). Potential spouses were chosen based on the potential groom's interest, but more often based on the desire of the family to find a good spouse and to build new relationships with the bride's natal household. Betrothal could occur as early as infancy, or later when the family feels it appropriate for the son to be married. A member of the potential groom's family sent gifts to the bride's family in a separate residential group or neighboring band to indicate interest. If interested, the gifts were accepted and the couple was officially betrothed. If betrothal occurred at a very early age, the couple would continue living in their natal households until they were recognized as adults. If the couple were already of marriageable age, they would be married with little ceremony. Gifts would be given between the two families to recognize the couple's new status and the new relationship between families. A two-to-three year period of brideservice would follow while the couple lived with the bride's natal household, after which they would move back to the husband's household or establish a new household in the vicinity of the husband's family. Gifts would continue to be given between the new couple and their in-laws as a sign of respect and to fulfill new kinship obligations. Thus marriage created new kin relationships and obligations that were met through the exchange of gifts and assistance. Gifts were not just material items but were endowed with meaning which fulfilled social obligations, demonstrated respect, measured status, and denoted kin or fictive kin relationships between individuals.

Feasts and ceremonies also were events rife with symbolism as guests were socially obligated to bring gifts to the host and the host was obligated to provide gifts to participants and guests. The very act of inviting a guest to a ceremony or feast created a wealth of obligations that reflected the relationship between guest and host and that were met with the exchange of appropriate material items. As Belshaw (1965) has noted, exchange permeates the social fabric and may be thought of as a network holding societies together.

As discussed in Chapter Two, Mauss (2002) first noted the obligations and relationships inherent in gift giving and identified the obligations of giving, receiving, and reciprocation. Individuals were obligated in various situations to give gifts, others were obligated to receive gifts, and upon receiving a gift the recipient was thus obligated to reciprocate. Sahlins (1965a, 1965b) elaborated the typology of exchange by articulating the well known trio of *generalized*, *balanced*, and *negative* reciprocity, while noting that the type of reciprocity was dependant on the social distance between agents. While Sahlins took a normative approach to the typology of exchange, Gosden (1989) focused on the power of socially obligated exchange and gift giving to create economic systems that function around the creation of debt and obligations.

Gifts and material goods operate in at least two realms, what Befu (1977) terms *expressive* and *instrumental* (see also Renfrew 2001; Robb 1999). While gifts may meet a material need, their *instrumental* nature, they also function on a semantic level to express meaning and value both between agents in the transaction and to the society that sanctions the transaction and relationship. Exchange, and its material component, is therefore a measure of the nature of the relationship being embodied through the act of exchange (Foster 1990). This association between the material item and the relationship then provides archaeologists the opportunity to go beyond simple models of exchange as the movement of materials through space (e.g., Fogel 1963; Renfrew 1972), to more socially meaningful examinations of past relationships and social roles created, maintained, and expressed through the production, exchange, and use of material goods.

The best archaeological sources for an exploration of the semantics of material goods are mortuary sites. There, the relationships between such anthropologically meaningful categories as sex, age, and social position and the material expressions of those categories are manifested more clearly than anywhere else in the archaeological record. Important to identifying material semantics is the principle that individuals are treated in death according to the socially sanctioned role they held in life (Goldstein 1980; Saxe 1970). Thus the burial of an individual is a social act by the living that expresses the role, status, and position the deceased was recognized as holding in life. The goods, and even people, that were interred with the deceased were material symbols of that role or position, as well as items necessary for use in the afterlife. In a very real sense, these goods were semantically empowered gifts given to the deceased that reflect the obligations that the deceased accrued from others in life.

As such, these goods are voices from the past—society's embodied symbolic expression, recognition, and sanctioning of the deceased's relationship to others within and outside his or her community. Analysis of these items relative to both normative categories such as sex and age, as well as to relative measures comparing individuals to one another, offers the hope of decoding these voices and better understanding the relationship between material goods, social structure, and the expressive nature of material culture.

Analysis

Here we revisit the mortuary components at the Reigh and Riverside sites, where material items ranging from copper beads to elaborately produced bifaces were interred with individuals of determinable age and sex. Both literature sources and collections at the Milwaukee Public Museum and the Wisconsin State Historical Society were examined to develop a detailed inventory of materials recovered from burial features. Since both sites frequently feature the burial of multiple individuals in the same feature, associating goods to specific individuals proved to be a serious obstacle. The two sites differed in this respect; at Reigh, the associations were quite clear even in multiple interments. This was due to the specific placement of grave goods in the hands, between the legs, or around the skull of the deceased, or in other locations well away from other individuals in the same feature. While the majority of the features at Riverside likewise had clear associations, one category of interments appears to have buried two or more individuals with the same items. These invariably consisted of at least one adult female and one child or infant, with goods deliberately placed in the space between the two (e.g., Hruska 1967:176-182).

As discussed in the previous chapter, data on the sex and age of individuals was compiled from published sources, including Hruska (1967), Binford (1972), Papworth (1967), and most importantly Pfeiffer (1977). Detailed metrics, counts, and descriptions of grave goods (Appendices III and IV) were compiled by analyzing the collections at the Milwaukee Public Museum and the Wisconsin State Historical Society during the summers of 2006 and 2007. The resulting data were tabulated by type of item, sex and age category of the associated individual(s), and total number of goods per individual. Sex was determined as male, female, juvenile unknown, and adult unknown. Due the Riverside female/juvenile burials, a fifth category of female/juvenile was added to the analysis.

Three lines of analysis were then conducted. First, a simple comparison between occupation sites and mortuary contexts showed that some elements of Late Archaic material culture were more often deposited with the dead than others. This implies that these materials were endowed with *expressive* value (sensu Befu 1977) by either individuals or the society as a whole. The identification of these semantically charged artifacts allows us to see a class of artifacts that, in some way, convey meaning about the individuals with whom they are interred.

Second, principal components analysis examined how these material items and categories of age and sex formed distinct and identifiable groups. Grave goods were counted per individual, and individual sex and age categories of male, female, juvenile, unknown adult, and female-juvenile and goods were used to identify each of the individuals. Principal components analysis was then conducted to identify socially valid groups of correlated attributes identified by age, sex, and material categories.

Third, an attempt is made to use expressive materials goods and categories of age and sex to understand the structure of the Archaic societies represented at Reigh and Riverside, and the relationship between social groups and expressive material goods. This is approached using a two-step process. For the first step, relationships between age, sex, and material goods were examined using bivariate correlations, creating a Pearson's R correlation matrix that assessed the degree of relationship between every category. Correlations with probabilities of $p<.05$ were considered significant, and were used to define important relationships between categories of goods and people.

The second step used network analysis to examine the emergent structure of the relationship between people and things. Network analysis examines "regularities in the patterns of relations among concrete entities" (White et al. 1977, quoted in Knoke and Yang 2008:4). This method allows for the identification of social groupings and relations that are emergent from the behavior and material/symbolic characteristics of that group (Degenne and Forsé 1999). The correlation matrix was used as a starting point for this approach; the direction and strength of every correlation is used to graphically represent these complex interrelationships as a network. Visualization of complex relationships is one strength of this approach, but network analysis also provides more rigorous means to examine structure and relationships within social "networks." Societies consist of a series of interacting and interrelated groups such as different families, sodalities, or hierarchies of power. Network analysis provides a means of identifying these constituent groups. The *k-core* method is one effective way of identifying subsets that are weakly connected to the total network but more strongly connected within (Knoke and Yang 2008:19-20), and was used in this analysis to divide the Reigh and Riverside networks into smaller constituent groups based on expressive material goods, age and sex. In social terms, these subgroups are associations between specific expressive elements of material culture and categories of age and sex. Put another way, they are social groups and their material symbols that are emergent properties of the behaviors of individuals in the society.

Another important element of network analysis is *centrality*. Centrality is a representation of a single item's, or node's position relative to the rest of the network. Central nodes are hubs, important to the functioning of the network as a whole. Those positions more central to the network are ones needed for the functioning of multiple elements of the social system at large, and studies have linked high network centrality to social power (Degenne and Forsé 1999:132-158). Centrality can be measured in many ways, two of which are used here. The first and most intuitive is *degree centrality*, which is simply a measure of the number of direct connections a node has to other nodes. Central items have strong connections to other network elements; peripheral ones do not (Degenne and Forsé 1999:132). While this is a simple and effective means to measure centrality, it ignores individual elements that have weak connections, but that are still indispensable to the functioning of the system as a whole. Individual elements that are intermediate between important network elements that must function together gain importance from their position between these important elements. These are the network bridges discussed in Chapter Two that connect different, more robustly interconnected, elements of the system but that are poorly represented by measures of degree centrality. *Betweenness* is a more effective means of identifying these elements (Degenne and Forsé 1999:136). Multiple paths (p) may connect subgroup a with subgroup b within the network, and the probability that any specific one will be used is $1/p_{ab}$. The probability that an element (i) will occupy any one of these paths and thus control interaction between the two subgroups is represented by $b_{ab}(i)$, or $p_{ab}(i)/p_{ab}$. Betweenness is then a sum of this figure for all possible paths, or a measure of the degree of importance point i has to the interaction between subgroups a and b (Degenne and Forsé 1999:136-137).

Networks were created from the correlation coefficients for Reigh and Riverside using the UCINET 6 software, and graphically displayed to visualize the system as a whole. Ego-centric displays were also developed to show the connections of males, females, and juveniles. Subgroups were then identified using the k-core method and linked to categories of male and female. Finally, degree centrality and betweenness were calculated for all elements involved in the networks, including categories of male, female, and juvenile as well as for expressive material culture associated with these categories.

Results

Artifacts at Reigh and Riverside burials were tabulated and compared to materials from the non-mortuary Duck Lake site to first identify types of materials that are unique to, or featured prominently within, mortuary contexts. Several categories were found to be unique to either mortuary or domestic contexts, with a few types found in both (Figure 6.1). Artifact types that

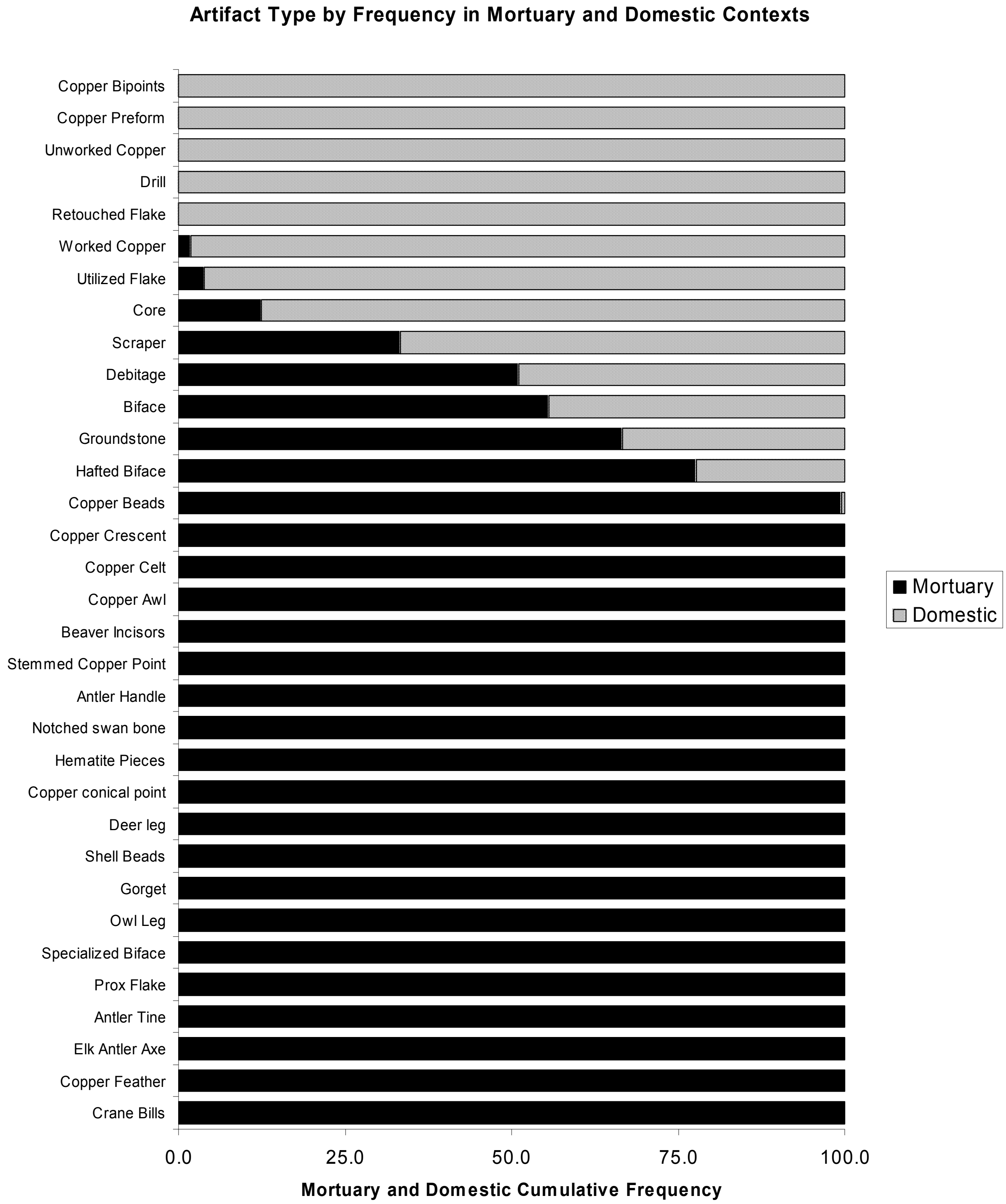


Figure 6.1. Stacked histogram of cumulative frequency of artifact categories by mortuary and domestic contexts.

were found more than 75 percent of the time with mortuary contexts were considered "mortuary" while those found less than 75 percent of the time were potentially unintentionally included in grave fill and were accordingly considered "domestic" in nature. The resulting list of "mortuary" items (Table 6.1) is therefore likely to consist of items that carry expressive value associated with such socially meaningful categories as age and sex.

Table 6.1. Artifact categories associated primarily with mortuary contexts.

Artifact Type	Reigh Burial	Riverside Burial	Total Burial	Duck Lake	Total	% Found in Mortuary Contexts	% Found in Domestic Contexts
Specialized Biface	6	191	197	0	197	100.0	0.0
Copper Feather	22	0	22	0	22	100.0	0.0
Hematite Pieces	4	3	7	0	7	100.0	0.0
Shell Beads	4	2	6	0	6	100.0	0.0
Stemmed Copper Point	0	5	5	0	5	100.0	0.0
Copper Awl	0	5	5	0	5	100.0	0.0
Antler Tine	3	0	3	0	3	100.0	0.0
Copper conical point	3	0	3	0	3	100.0	0.0
Notched swan bone	3	0	3	0	3	100.0	0.0
Copper Crescent	0	3	3	0	3	100.0	0.0
Crane Bills	2	0	2	0	2	100.0	0.0
Elk Antler Axe	2	0	2	0	2	100.0	0.0
Beaver Incisors	0	2	2	0	2	100.0	0.0
Copper Celt	0	2	2	0	2	100.0	0.0
Prox Flake	1	0	1	0	1	100.0	0.0
Owl Leg	1	0	1	0	1	100.0	0.0
Gorget	1	0	1	0	1	100.0	0.0
Deer leg	1	0	1	0	1	100.0	0.0
Antler Handle	1	0	1	0	1	100.0	0.0
Copper Beads	12	593	605	3	608	99.5	0.5
Hafted Biface	6	8	14	4	18	77.8	22.2

Specialized exotic chert bifaces, as discussed in Chapter Five, and several categories of copper artifacts are prominent on this list. Copper items that likely carry expressive value include beads, stemmed copper points, crescents, and celts. Other categories likely to carry expressive value include pieces of hematite, marine shell beads and gorgets, and some hafted bifaces. A unique feature of the Reigh site is the presence of bird bone tubes and a complete owl leg that may be associated with specific social roles in that community. Other artifacts exclusive to Reigh that carry meaning include antler tines and elk antler axe handles.

These categories were then used in a principal components analysis as the first approach to identifying structure inherent within categories of material goods and age/sex categories. For the Reigh site, this resulted in three factors that cumulatively account for 84.5 percent of the variance (Table 6.2).

Table 6.2. Extracted component scores for Reigh site age and sex categories.

	Principal Component		
Age/Sex	**1**	**2**	**3**
Male	-0.526	0.697	0.122
Female	0.796	0.025	-0.383
Juvenile	-0.304	-0.808	0.275
Unknown	0.559	0.181	0.809
Eigenvalue	1.315	1.173	0.892
% of Variance	32.863	29.316	22.291

These three factors are closely associated with males, females, and unknown adults, and demonstrate that Reigh society prominently recognized different social categories for male and female, with some unknown adults comprising a third distinct group. Factor 1 is a group of traits that is closely associated with females and adult unkowns, but *not* with males or juveniles. Some of the adult unknowns are likely to represent adult females based on their positive association with this factor. Factor 2 identifies a group of traits that is closely associated with adult males, but *not* juveniles, and Factor 3 identifies a cluster of traits that closely associates with adult unknowns but *not* females. These adult unknowns are likely to be juveniles or adult males. The unknown group is likely to be comprised of poorly preserved and unidentified females, unidentified males, and other members of the society that lack specific distinctions. Alternatively, they perhaps comprise a third gender category or interment type (primary, secondary, or cremation) affects the type of materials deposited with the dead.

It is remarkable that juveniles do not appear as a group, or closely associated with any group, in Reigh society. Juveniles lack specific material traits, and are not buried with their own grave goods.

But what are these clusters of traits? To explore this question, categories of material goods were correlated with the sexes, ages, and total number of individuals buried per feature. The Reigh bivariate correlation matrix, shown in Table 6.3, demonstrates that adult males are positively correlated with such items as antler tines, antler handles, owl leg bones, and the total number of individuals per grave, and negatively correlated with the presence of females. Adult females exhibit only one significant correlation, a negative correlation with the presence of males. Juveniles are positively correlated with the presence of copper feathers, antler points, crane bills, and the total number of individuals per grave. However, a closer look at these relationships indicates that they can be more accurately described as a tendency for juveniles to be buried with males that have these material characteristics.

To better visualize and analyze the complex set of interrelationships represented by these correlations, they were subjected to network analysis using UCINET 6 software. The bivariate correlations were used as measures of the strength and direction of relationships between all material, age, and sex categories. The network analysis software first combines these relationships into a composite display, as shown in Figure 6.2. This network display is thus a

Table 6.3. Pearson's R correlation matrix of Reigh site mortuary goods and sex and age categories. Correlations that are significant at the p=.05 level are shown in bold and outlined in boxes.

	Cop Feather	Cop Bead	Cop Point	Ant Point	Spec Biface	Haft Biface	Ant Tine	Axe	Ant Handle	Owl Leg	Bone Tube	Gorget	Shell Bead	Crane Bill	No. Indiv	Male	Female	Juvenile	Unk
Cop Feath	1.000	-0.045	-0.083	**1.000**	-0.112	-0.071	-0.045	-0.066	-0.045	-0.045	-0.062	-0.045	-0.045	**1.000**	**0.756**	0.117	0.223	**0.650**	**0.663**
Cop Bead	-0.045	1.000	-0.083	-0.045	-0.112	-0.071	-0.045	-0.066	-0.045	-0.045	-0.062	**1.000**	**1.000**	-0.045	0.121	-0.220	0.223	-0.123	0.405
Cop Point	-0.083	-0.083	1.000	-0.083	**0.422**	-0.128	-0.083	0.339	-0.083	-0.083	**0.464**	-0.083	-0.083	-0.083	-0.164	0.213	-0.112	-0.224	-0.204
Ant Point	**1.000**	-0.045	-0.083	1.000	-0.112	-0.071	-0.045	-0.066	-0.045	-0.045	-0.062	-0.045	-0.045	**1.000**	**0.756**	0.117	0.223	**0.650**	**0.663**
Spec Biface	-0.112	-0.112	**0.422**	-0.112	1.000	-0.175	-0.112	0.211	0.405	0.405	**0.553**	-0.112	-0.112	-0.112	-0.076	0.123	0.128	-0.177	-0.150
Haft Biface	-0.071	-0.071	-0.128	-0.071	-0.175	1.000	-0.071	**0.603**	-0.071	-0.071	-0.096	-0.071	-0.071	-0.071	-0.206	-0.027	-0.052	-0.191	-0.175
Ant Tine	-0.045	-0.045	-0.083	-0.045	-0.112	-0.071	1.000	-0.066	-0.045	-0.045	-0.062	-0.045	-0.045	-0.045	**0.502**	**0.454**	-0.204	0.392	0.405
Axe	-0.066	-0.066	0.339	-0.066	0.211	**0.603**	-0.066	1.000	-0.066	-0.066	**0.599**	-0.066	-0.066	-0.066	-0.192	0.170	-0.295	-0.178	-0.163
Ant Handle	-0.045	-0.045	-0.083	-0.045	0.405	-0.071	-0.045	-0.066	1.000	**1.000**	**0.414**	-0.045	-0.045	-0.045	0.121	**0.454**	-0.204	-0.123	0.146
Owl Leg	-0.045	-0.045	-0.083	-0.045	0.405	-0.071	-0.045	-0.066	**1.000**	1.000	**0.414**	-0.045	-0.045	-0.045	0.121	**0.454**	-0.204	-0.123	0.146
Bone Tube	-0.062	-0.062	**0.464**	-0.062	**0.553**	-0.096	-0.062	**0.599**	**0.414**	**0.414**	1.000	-0.062	-0.062	-0.062	-0.065	0.314	-0.279	-0.168	-0.036
Gorget	-0.045	**1.000**	-0.083	-0.045	-0.112	-0.071	-0.045	-0.066	-0.045	-0.045	-0.062	1.000	**1.000**	-0.045	0.121	-0.220	0.223	-0.123	0.405
Shell Bead	-0.045	**1.000**	-0.083	-0.045	-0.112	-0.071	-0.045	-0.066	-0.045	-0.045	-0.062	**1.000**	1.000	-0.045	0.121	-0.220	0.223	-0.123	0.405
Crane Bill	**1.000**	-0.045	-0.083	**1.000**	-0.112	-0.071	-0.045	-0.066	-0.045	-0.045	-0.062	-0.045	-0.045	1.000	**0.756**	0.117	0.223	**0.650**	**0.663**
No. Indiv	**0.756**	0.121	-0.164	**0.756**	-0.076	-0.206	**0.502**	-0.192	0.121	0.121	-0.065	0.121	0.121	**0.756**	1.000	**0.423**	0.131	**0.767**	**0.864**
Male	0.117	-0.220	0.213	0.117	0.123	-0.027	**0.454**	0.170	**0.454**	**0.454**	0.314	-0.220	-0.220	0.117	0.423	1.000	**-0.436**	0.069	0.290
Female	0.223	0.223	-0.112	0.223	0.128	-0.052	-0.204	-0.295	-0.204	-0.204	-0.279	0.223	0.223	0.223	0.131	**-0.436**	1.000	-0.027	0.023
Juvenile	**0.650**	-0.123	-0.224	**0.650**	-0.177	-0.191	0.392	-0.178	-0.123	-0.123	-0.168	-0.123	-0.123	**0.650**	**0.767**	0.069	-0.027	1.000	**0.524**
Unknown	**0.663**	0.405	-0.204	**0.663**	-0.150	-0.175	0.405	-0.163	0.146	0.146	-0.036	0.405	0.405	**0.663**	**0.864**	0.290	0.023	**0.524**	1.000

Table 6.4. Centrality measures for the Reigh site network elements.

Category	Degree Centrality	Betweenness
Male	13	43.607
Adult Unknown	13	20.402
No. Individuals	13	20.402
Female	9	11.429
Antler Point	7	0.367
Copper Feathers	7	0.367
Copper Beads	5	0.000
Specialized Bifaces	7	10.262
Antler Tines	4	0.000
Bird Bone Tubes	6	2.000
Crane Bills	7	0.367
Juvenile	7	0.750
Antler Handles	6	2.024
Owl Leg	6	2.024
Axe Handles	5	17.000
Copper Points	4	0.000
Gorget	5	0.000
Shell Beads	5	0.000
Hafted Bifaces	1	0.000

picture of the emergent structure between material symbols, ages and sex, and the social relationships that these categories represent.

Adult males are both visually and mathematically central to the emergent structure of the Reigh social network, with a degree centrality of 13 and a betweenness centrality of 43.6 (Table 6.4). Females also have relatively high centrality, with a degree centrality of 9 and a betweenness value of 11.4. Juveniles are correlated with seven other categories (degree centrality = 7), yet their betweenness value of 0.75 is very low, illustrating that they are peripheral to the relationships of the network and confirming that their correlation with such material types as copper feathers and antler points is due to their association with males and not to the association of these categories with the juveniles themselves.

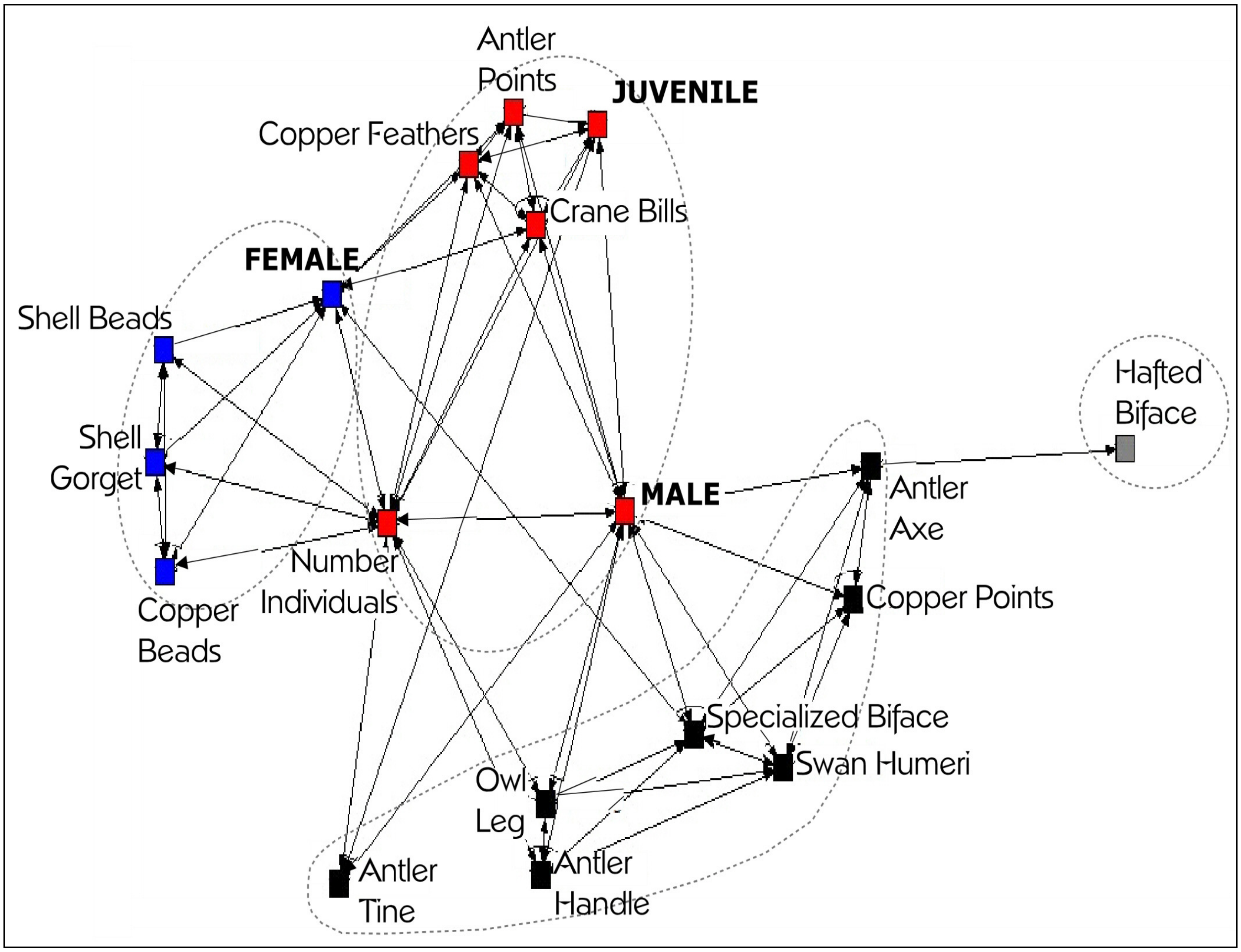


Figure 6.2. Network diagram of the correlations between mortuary goods and age and sex categories at the Reigh site. Subgroups identified by k-core analysis are shown by dashed lines.

Males are associated with two different groups of material symbols, as illustrated in Figure 6.3 which displays the male-centric network from Reigh. This male centric network has been divided into constituent goups using the k-core method. The two primary constituent groups include a group of burials containing bird bone tubes, antler axe handles, large hafted (specialized) bifaces, antler handles, and copper points. This is the largest of the two male-associated groups, and is represented in burials 4, 5, 11, 18, 23, 25, and 26. Several individuals are often found in these graves, including males and females but no juveniles.

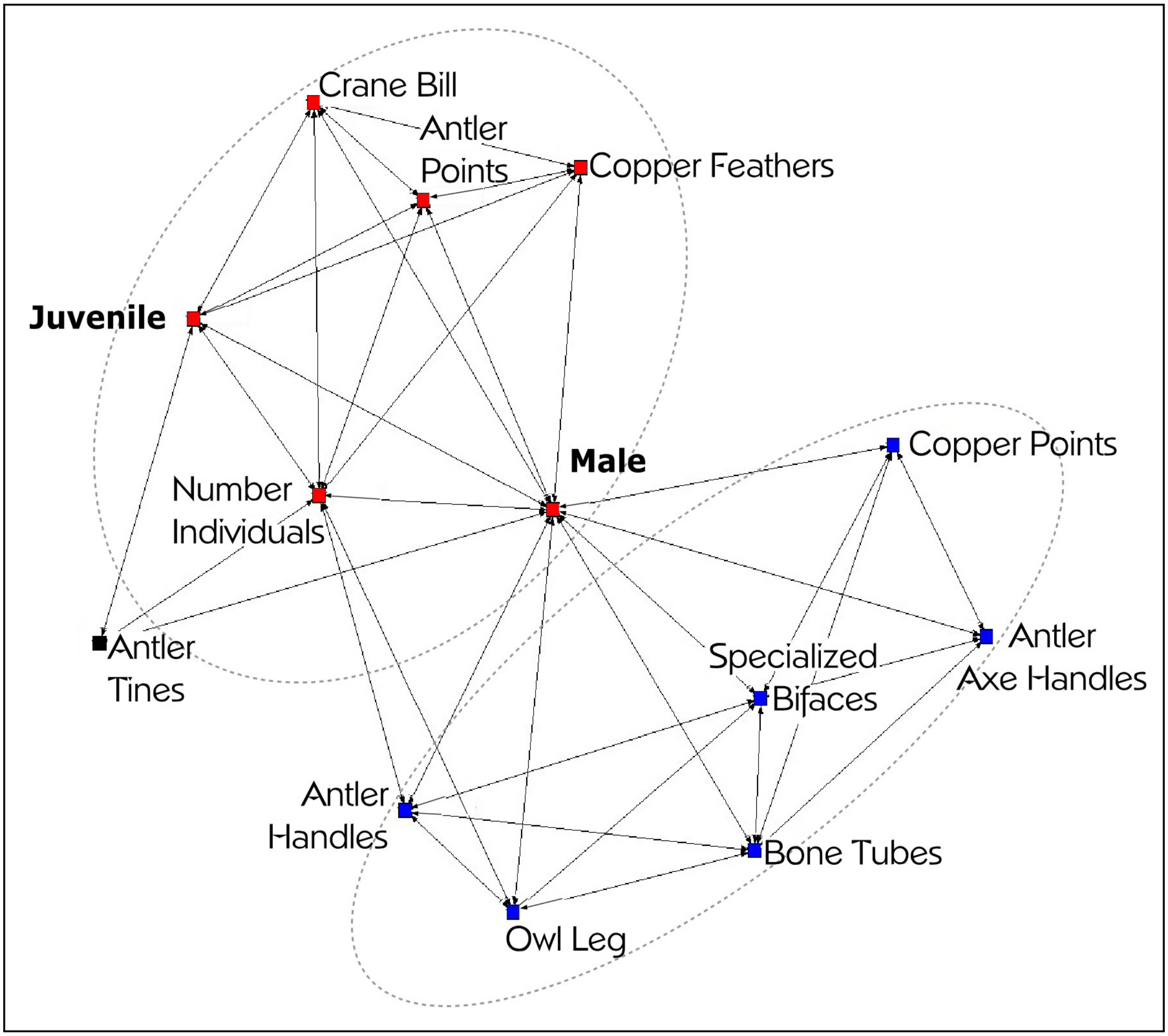


Figure 6.3. Male-centric network diagram, showing the relationship between adult males and categories of grave goods at Reigh. Two k-core subgroups are identified by the dashed ovals.

The second male-associated group consists of graves with multiple individuals including juveniles, and which may also contain copper feathers, antler points, and crane bills. This is a tightly linked network of traits which is also linked to females through their association with the males that possess these traits (see Figure 6.4). This group is also more exclusive, and is only represented by burials 6 and 10.

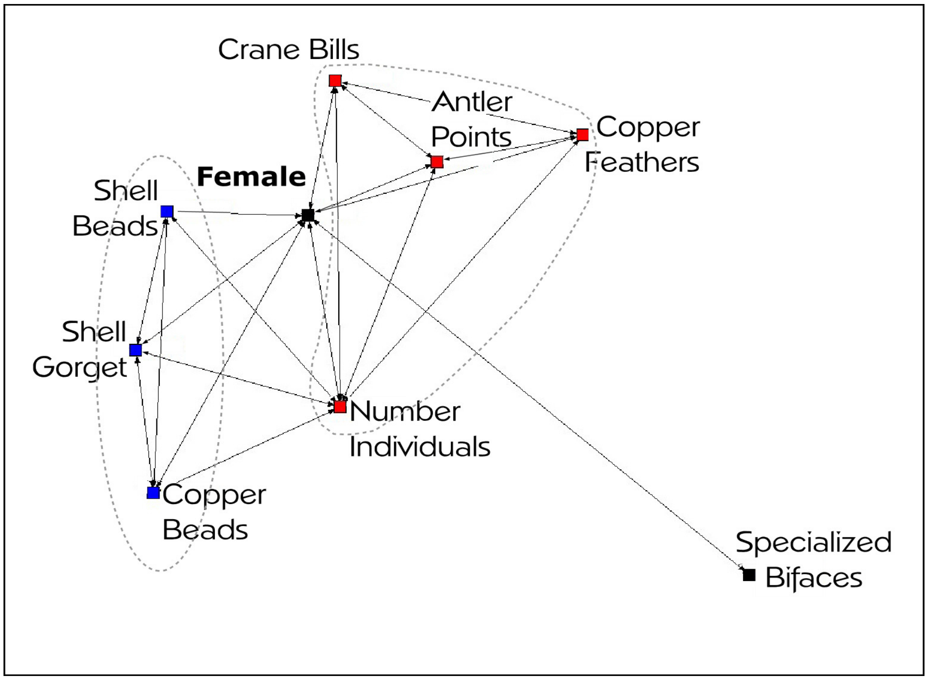


Figure 6.4. Female-centric network diagram showing the relationship between adult females and mortuary associations at Reigh. Subgroups identified through k-core analysis shown as dashed lines.

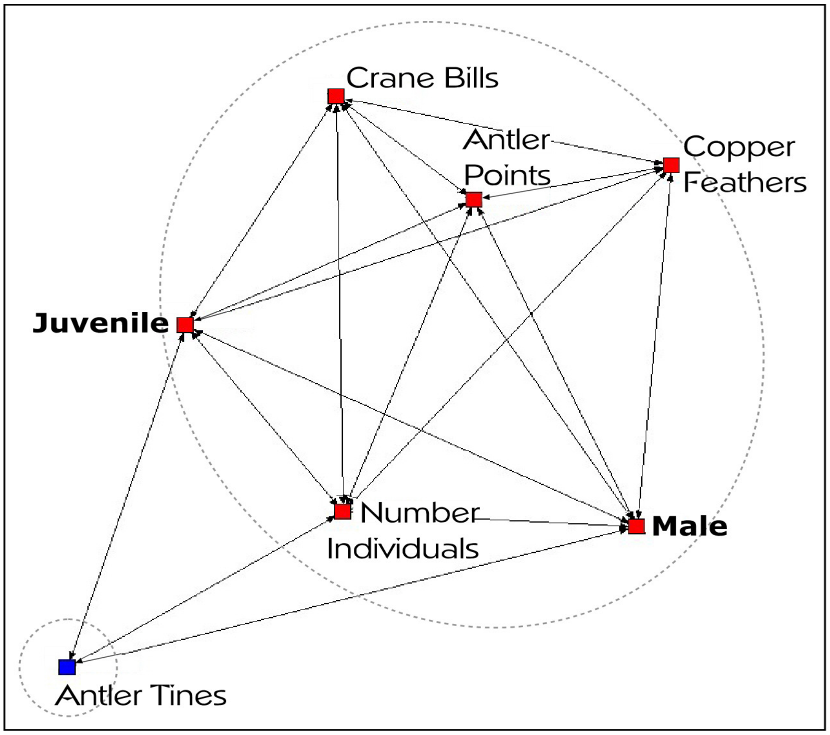


Figure 6.5. Juvenile-centric network showing the relationship between juveniles and other mortuary associations at Reigh. Subgroups identified by k-cores are shown with dashed ovals.

Females are also linked to two different groups (Figure 6.4). The first of these is the male-associated group of antler points, juveniles, copper feathers, and number of individuals per grave. It is notable that k-core analysis of the female-centric network shows that females do not belong to this group, but are linked to it through their association with males who possess these material symbols. Females are also associated with a tightly linked network of copper beads, shell beads, and a shell gorget. This represents one feature, burial 13, in which a young adult female was buried with these items.

Juveniles are associated with one group—the male subnetwork of copper feathers, antler points, and crane bills (Figure 6.5). Again, their association with this group is not a result of juveniles possessing these material traits, but rather of the association of juveniles with males who possess these items.

The picture that emerges from this analysis is of a small-scale graded or ranked society in which males gain social position and reproductive fitness through their accomplishments, and that these accomplishments are symbolized by different material items. We can explore this life history through examining the relationships between male, females, juveniles and material goods. Increased reproductive fitness is a result of favorable competition with rivals for potential mates. Put another way, those individuals with higher reproductive fitness have become members of more exclusive groups as recognized by potential mates and society at large. This generation of exclusivity can be tracked in the social network by working backward from high betweenness values (less exclusive traits linked to multiple individuals and symbols) to low betweenness values (more exclusive traits linked to fewer individuals), and tracking the relationship between these values and males, females, and their offspring. Such an analysis is shown in Figure 6.6,

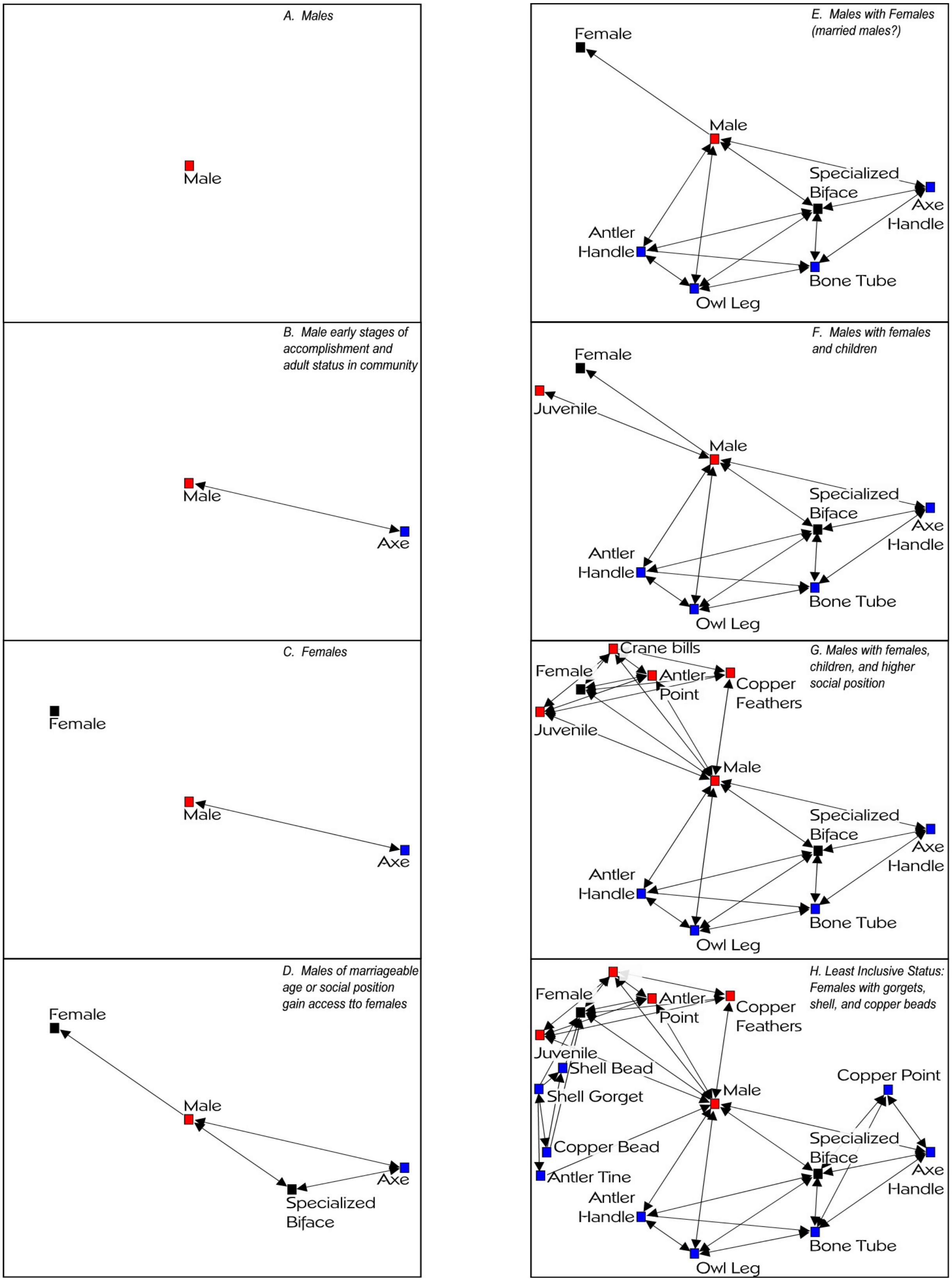


Figure 6.6. Development of male social position and access to females in Reigh society.

which illustrates the changing relationships between males, females and material symbols. Males most inclusive (highest betweenness) category is with the material symbols associated with antler axe handles. Axe handles are most closely correlated with hafted bifaces, and may represent a social recognition as young adult males. After attaining this social position, males then marry and gain access to specialized bifaces. Subsequent social recognition gains access to symbols such as bird bone tubes and owl legs—symbols that may represent positions attainable only after marriage. It is at this point that reproduction appears to occur, as juveniles become associated with males and females, which seems to open opportunities for a few males to gain additional social position as symbolized by copper feathers, antler points, and crane bills which likely represent particular rights or responsibilities within the society.

Females and juveniles are associated traits of male social accomplishment. Juveniles in particular are a result of male accomplishment, yet have little inherent social position or value. Materials that symbolize accomplishment are largely of local origin, and function within a small-scale community to accurately display position or rank among marriageable age males. Symbols of accomplishment and social value are only associated with adults—never with juveniles—revealing that competition for mates most often occurs within the community between males of adult age rather than by families arranging marriages for young children. Further, the relationships created through marriage are important to male social position, as indicated by increased access to symbols of grade or rank for males associated with females (Figure 6.6E) and for males associated with juveniles (Figure 6.6F).

Females in Reigh society gain reproductive fitness and social position largely through relationships with accomplished males. On their own, females have few symbols of social position in death, but when associated with males they may display specialized bifaces. In one case, however, a young adult female lacking clear male associations was found with distinctive material symbols. Burial 13 represents this individual, and other associated females, who have relationships with distant communities revealed through the presence of marine shell beads and a sandal-sole gorget typical of Glacial Kame communities to the southeast (Cunningham 1948). This is the only case at Reigh in which distant exotic materials define a distinct category of individuals. This category is not linked to reproduction through juveniles or males, but may represent the early development of distant inter-community relationships.

Table 6.5. Extracted component scores for Riverside site age and sex categories.

Age/Sex	**Principal Component** **1**	**2**	**3**
Male	-0.187	-0.529	0.823
Female	0.942	0.202	0.149
Juvenile	-0.440	0.753	0.115
Unknown	0.921	0.255	0.161
Fem/Juvenile	-0.243	0.796	0.348
Eigenvalue	2.023	1.586	0.860
% of Variance	40.462	31.720	17.204

A very different picture emerges from the same analysis performed on the Late Archaic Riverside data. As before, analysis first begins with a principal components analysis to identify social groups represented in the data by sex, age, and associated material goods. A principal components analysis revealed three factors that account for 89.4 percent of the variance (Table 6.5). The component matrix indicates that Factor 1 represents a group of females and unknown adults—likely also females but unidentifiable due to poor preservation at the site. Factor 2 represents a group, not present at Reigh, of juveniles and females/juvenile pairs and *excluding* males. The third factor, representing only 17.2 percent of the variance, is males. Thus Riverside society has recognized a new social group that includes juveniles, some as young as infants, who have large quantities of material goods and are buried with those goods either when buried alone or when buried with adult females who are likely their female relatives or mothers. Females buried with infants are also often accompanied by large quantities of exotic goods, including specialized bifaces and hundreds of copper beads.

Correlation analysis was again performed to gain a better understanding of the relationships between material goods and age/sex characteristics. Again, the emphasis has shifted from males at Reigh to juveniles at Riverside (Table 6.6). Adult males show only one significant correlation, a negative correlation with the presence of juveniles. Females have no correlations that meet the significance criteria, while juveniles have significant positive correlations with the presence of copper beads, copper celts, and the total number of items per interment, and significant negative correlations with the presence of adult males and adults of unknown sex.

Again using network analysis to visualize the complex relationships between material goods and age and sex categories produces the diagram shown in Figure 6.7. Perhaps the most striking difference between this diagram and the one shown in Figure 6.2 for the Reigh site, is the central nature of juveniles at Riverside who have replaced the adult males at Reigh. At Riverside, juveniles have a degree centrality of 10, females 9, and males only 4 (Table 6.7). Other elements with a high degree centrality include the total number of individuals, copper beads, and specialized Wyandotte bifaces. Juveniles at Riverside exhibit a betweenness value significantly higher than any other element considered in this analysis, followed again by the number of associated individuals, females, copper beads, copper awls, and specialized Wyandotte bifaces. Males have a much lower betweenness value, and social display of male

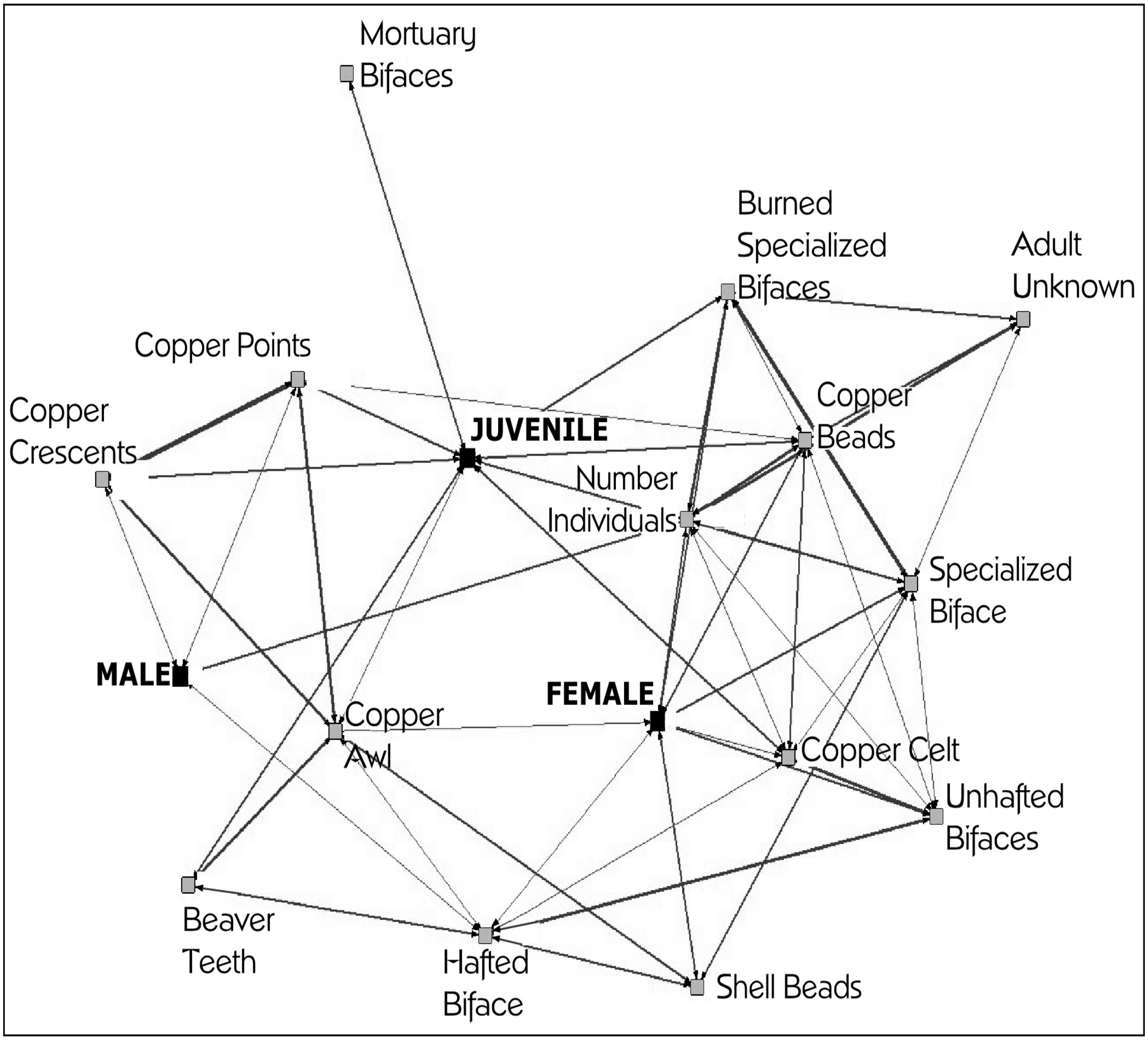


Figure 6.7. Network diagram of the correlations between mortuary goods and age and sex categories at the Riverside site.

accomplishment is less prominent within the Riverside community. The change in centrality measures from Reigh to Riverside is dramatic and important; male centrality declines greatly, female centrality less so and juvenile centrality increases dramatically (Figure 6.8). These indicate that important changes in the importance of juveniles, males, and females have already occurred or are taking place in Riverside society.

Table 6.6: Pearson's R correlation matrix of Riverside site mortuary goods and sex and age categories. Correlations that are significant at the p=.05 level are shown in bold and outlined by boxes.

	Copper					Wyandotte			Other						Age and Sex			
	Beads	Celt	Awl	Cresc	Point	Mort. Biface	Burned Biface	Biface	Hafted Biface	Other Biface	Shell Beads	Beaver Teeth	No. Indiv.	Total Goods	Male	Fem	Juv.	Adult Unk.
Copper Beads	1.000	0.329	-0.094	-0.065	-0.058	-0.001	0.051	-0.048	-0.040	0.099	-0.048	-0.061	**0.553**	**0.939**	-0.137	0.258	**0.340**	0.158
Copper Celt	0.329	1.000	-0.081	-0.056	-0.050	0.070	-0.058	-0.041	0.083	**0.386**	-0.041	-0.052	0.077	0.310	-0.119	0.086	**0.343**	-0.170
Copper Awl	-0.094	-0.081	1.000	**0.535**	**0.592**	-0.039	-0.080	-0.056	0.028	-0.121	0.282	**0.467**	-0.165	-0.096	-0.164	0.118	0.118	-0.233
Copper Crescent	-0.065	-0.056	**0.535**	1.000	**0.975**	-0.073	-0.055	-0.039	-0.098	-0.083	-0.039	-0.049	-0.114	-0.069	0.081	-0.162	0.162	-0.161
Copper Point	-0.058	-0.050	**0.592**	**0.975**	1.000	-0.066	-0.049	-0.035	-0.088	-0.075	-0.035	-0.045	-0.102	-0.059	0.003	-0.146	0.204	-0.144
Spec. Biface	-0.001	0.070	-0.039	-0.073	-0.066	1.000	**7.000**	-0.054	-0.032	0.080	0.151	-0.069	0.225	0.171	-0.156	0.244	0.172	0.023
Burned Wy. Biface	0.051	-0.058	-0.080	-0.055	-0.049	**0.700**	1.000	-0.040	-0.102	-0.086	-0.040	-0.051	**0.429**	0.213	-0.117	0.129	0.129	0.163
Wyandotte Biface	-0.048	-0.041	-0.056	-0.039	-0.035	-0.054	-0.040	1.000	-0.072	-0.061	-0.029	-0.036	-0.084	0.235	-0.083	-0.120	0.239	-0.118
Hafted Biface	-0.040	0.083	0.028	-0.098	-0.088	-0.032	-0.102	-0.072	1.000	**0.569**	0.188	0.157	-0.143	-0.054	0.114	0.060	-0.121	-0.156
Other Biface	0.099	**0.386**	-0.121	-0.083	-0.075	0.080	-0.086	-0.061	**0.569**	1.000	-0.061	-0.078	0.056	0.094	-0.086	0.205	-0.026	-0.010
Shell Beads	-0.048	-0.041	0.282	-0.039	-0.035	0.151	-0.040	-0.029	0.188	-0.061	1.000	-0.036	-0.084	-0.031	-0.083	0.239	-0.120	-0.118
Beaver Teeth	-0.061	-0.052	**0.467**	-0.049	-0.045	-0.069	-0.051	-0.036	0.157	-0.078	-0.036	1.000	-0.107	-0.070	-0.106	-0.038	0.191	-0.151
No. Individuals	**0.553**	0.077	-0.165	-0.114	-0.102	0.225	**0.429**	-0.084	-0.143	0.056	-0.084	-0.107	1.000	**0.564**	0.212	0.319	0.032	**0.487**
Total Goods	**0.939**	0.310	-0.096	-0.069	-0.059	0.171	0.213	0.235	-0.054	0.094	-0.031	-0.070	**0.564**	1.000	-0.187	0.254	**0.430**	0.125
Male	-0.137	-0.119	-0.164	0.081	0.003	-0.156	-0.117	-0.083	0.114	-0.086	-0.083	-0.106	0.212	-0.187	1.000	-0.050	**-0.347**	-0.108
Female	0.258	0.086	0.118	-0.162	-0.146	0.244	0.129	-0.120	0.060	0.205	0.239	-0.038	0.319	0.254	-0.050	1.000	-0.125	-0.297
Juvenile	**0.340**	**0.343**	0.118	0.162	0.204	0.172	0.129	0.239	-0.121	-0.026	-0.120	0.191	0.032	**0.430**	**-0.347**	-0.125	1.000	**-0.396**
Adult Unknown	0.158	-0.170	-0.233	-0.161	-0.144	0.023	0.163	-0.118	-0.156	-0.010	-0.118	-0.151	**0.487**	0.125	-0.108	-0.297	**-0.396**	1.000

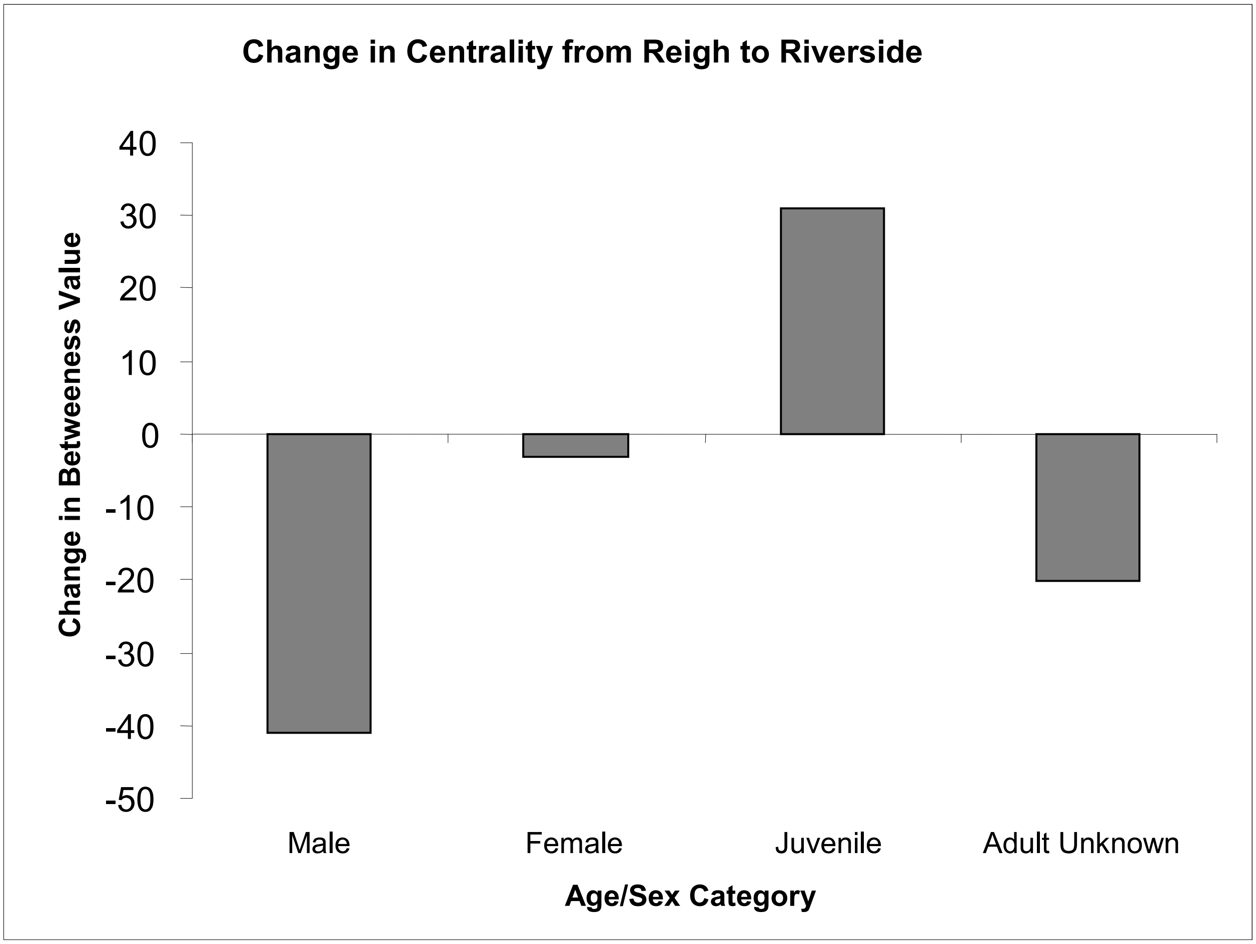


Figure 6.8. Changes in betweenness centrality measures by age and sex category from the Middle Archaic society at Reigh and the Late Archaic society represented at Riverside.

Juveniles exhibit direct correlations with three different groupings of material goods, and are intermediate between the two largest of these as demonstrated by a k-core division of the juvenile-centric network (Figure 6.9). The first is with a cluster of copper points, copper crescents and copper awls. The second major group consists of formal Wyandotte chert bifaces, burned Wyandotte chert bifaces from cremations, copper beads, copper celts and the total number of individuals per grave. Finally, juveniles are also associated with ovate chert bifaces. In Feature 63, 110 of these had been placed in a deliberate pattern upon which a child had been buried. (Hruska 1967:224-225).

Table 6.7. Degree and betweenness centrality measures for mortuary categories at Riverside.

Category	Degree Centrality	Betweenness
Juvenile	10	31.687
No. Individuals	9	9.848
Copper Awls	7	8.722
Female	9	8.437
Hafted Bifaces	7	8.056
Copper Beads	8	7.889
Exotic Chert Bifaces	8	7.528
Copper Celts	7	2.837
Copper Points	5	2.711
Male	4	2.556
Burned Exotic Bifaces	6	1.926
Other Bifaces	6	1.226
Copper Crescents	5	1.000
Shell Beads	4	0.767
Beaver Teeth	3	0.667
Adult Unknown	4	0.143
Mortuary Bifaces	1	0.000

The two main groups with which juveniles are associated are demonstrably linked to males and females. A female-centric network (Figure 6.10) demonstrates the association of females with the group of mortuary bifaces, copper beads, copper celts, burned Wyandotte bifaces, and the total number of individuals per grave. A k-core analysis of this female-centric network reveals that females also lie between two different associations; the first being the juvenile associated group just described, while the second consists of an association of shell beads, hafted bifaces, and copper awls.

Males have limited associations, but are grouped with the copper points and copper crescents that are associated with juveniles (Figure 6.11). Males are less strongly associated with the number of individuals per grave, and with hafted bifaces.

As with the Reigh site, an evaluation of reproductive fitness can be conducted by examining betweenness values; decreasing betweenness values may correlate with increasing success in competition for reproductive access. However, at Riverside this analysis is somewhat more complex due to the greater frequency of grave goods per individual. In this case, several categories of material goods were found to not lie intermediate between males, females, and juveniles—in other words these material symbols do not provide an unambiguous signal of social position relative to reproductive fitness. As a result, the categories of copper awls, copper celts, beaver teeth, hafted and unhafted bifaces, shell beads, burned bifaces, mortuary bifaces (non exotic), and adult unknown were excluded from the following analysis.

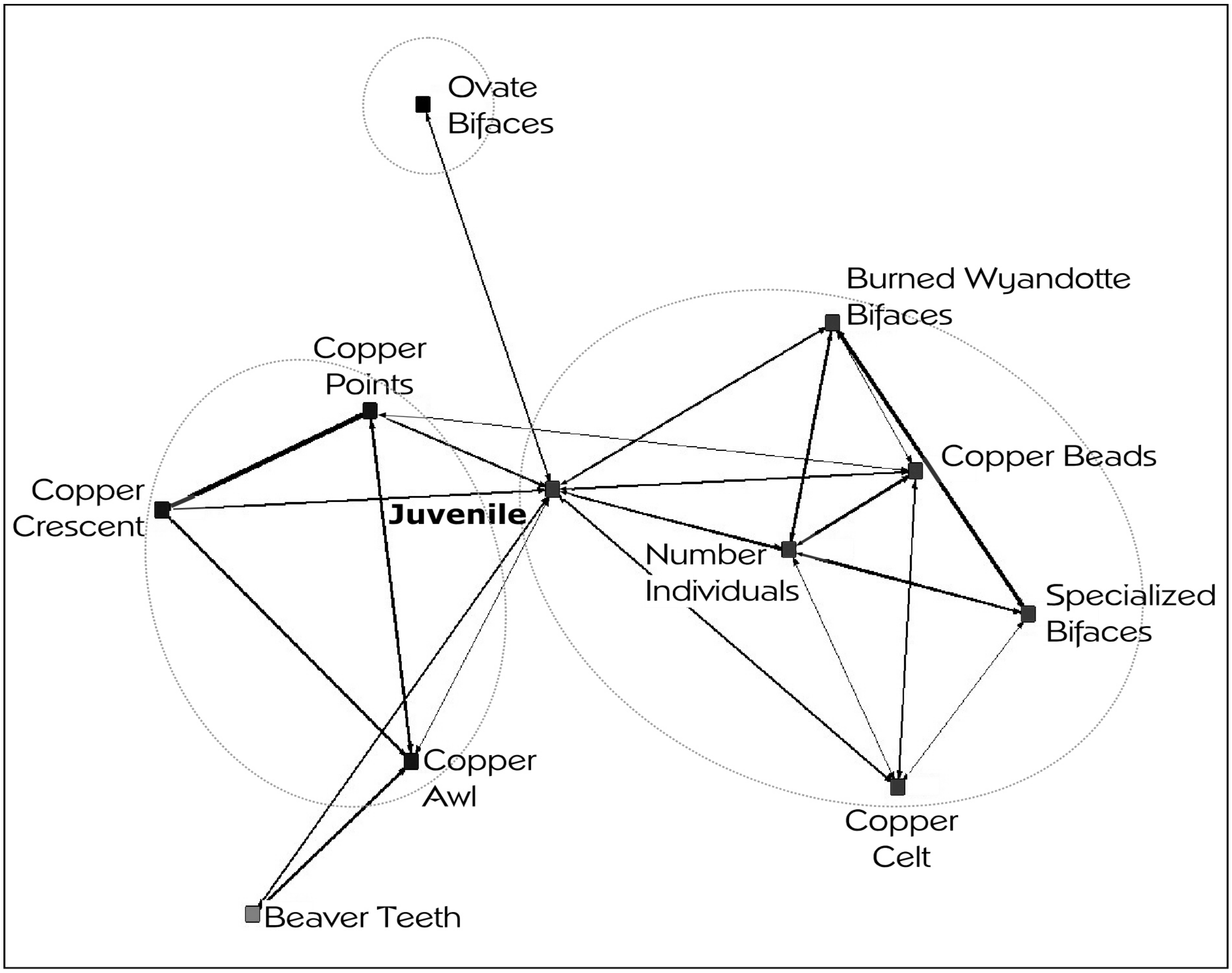


Figure 6.9. Juvenile-centric network showing the relationship between juveniles and other mortuary associations at Riverside. K-cores are illustrated to demonstrate the three primary group with which Juveniles are directly associated. Note that Juveniles are located on the majority of the paths between the two major groups.

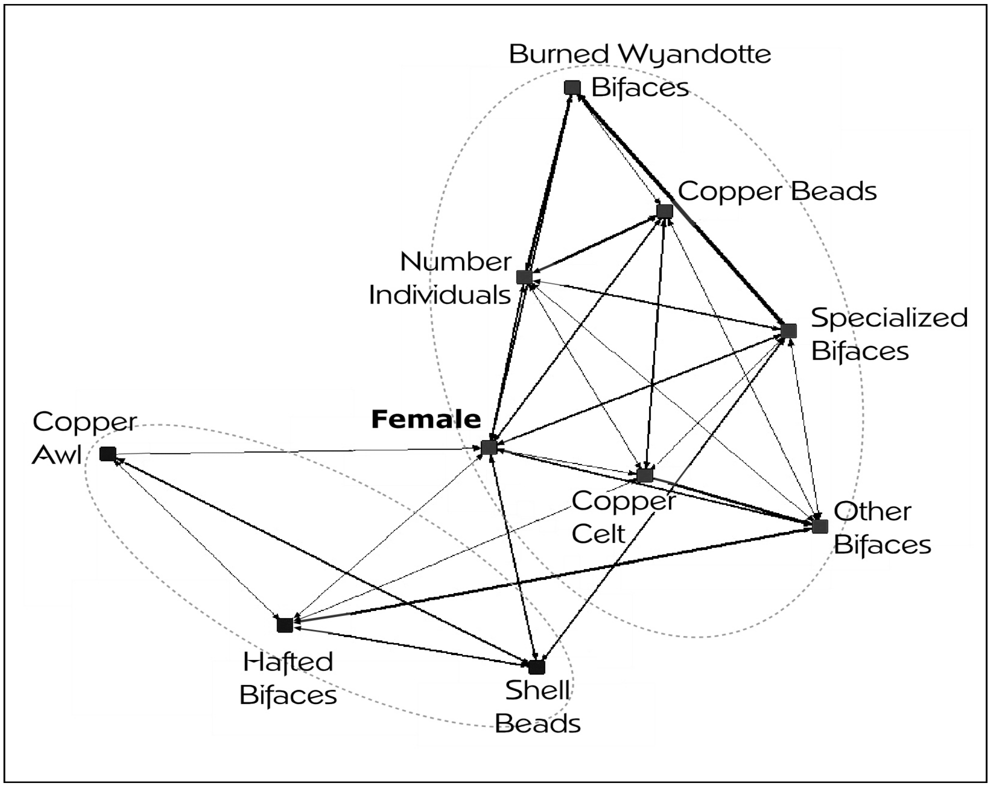


Figure 6.10. Female-centric network showing the relationship between juveniles and other mortuary associations at Riverside. Females are associated with two groups, as demonstrated by the k-core analysis shown here.

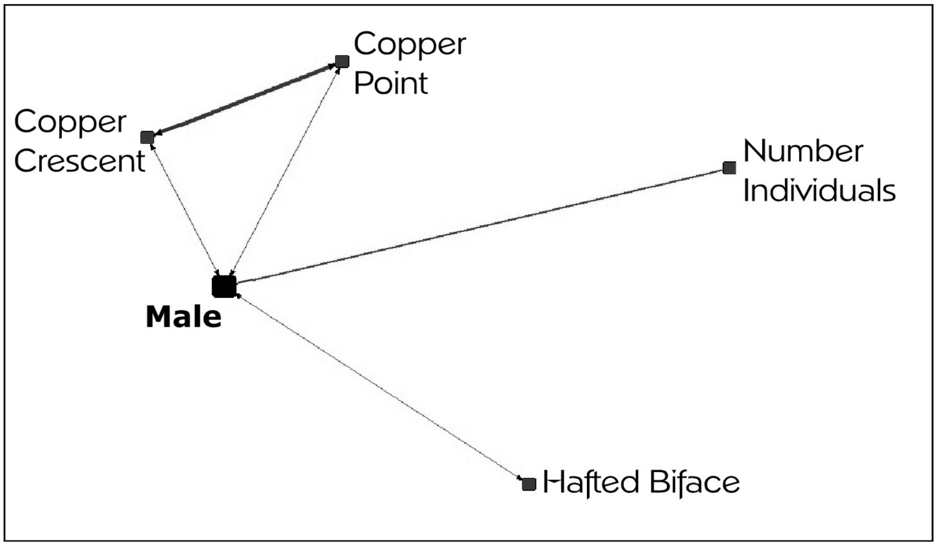
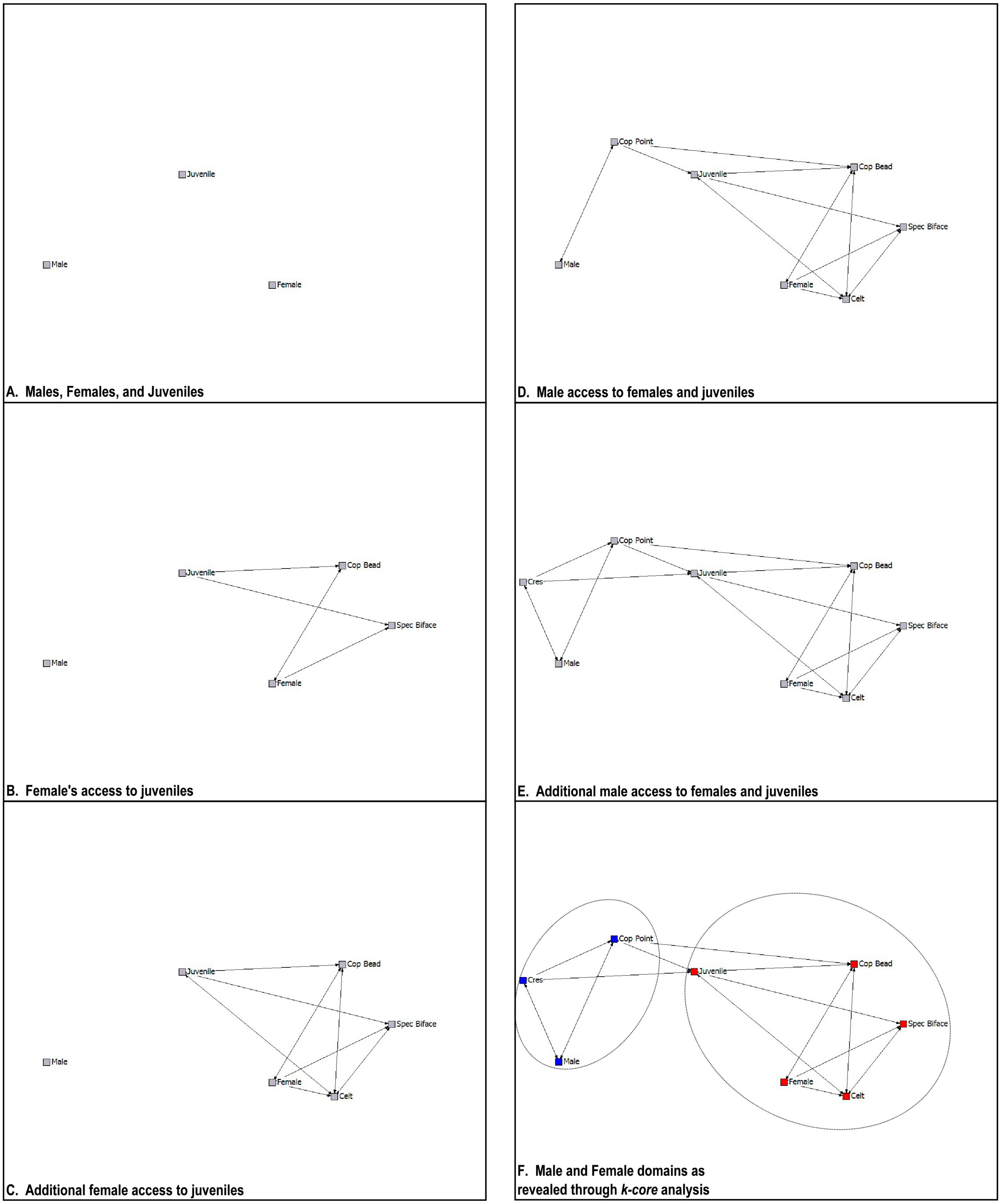


Figure 6.11. Male-centric network showing the relationship between juveniles and other mortuary associations at Riverside.



A. Males, Females, and Juveniles

B. Female's access to juveniles

C. Additional female access to juveniles

D. Male access to females and juveniles

E. Additional male access to females and juveniles

F. Male and Female domains as revealed through *k-core* analysis

Figure 6.12. Increasing reproductive access and the material symbols of relevant social position in Riverside society.

Figure 6.12 represents the series of associations, at decreasing betweenness values and increasing fitness values, which link females, juveniles, and ultimately males. Female reproductive fitness is the first set of associations. Female access to juveniles (or reproduction) is mediated through material categories of copper beads, Wyandotte bifaces, and copper celts. These copper and exotic lithic items in some way symbolize enhanced reproductive fitness for females, perhaps as signals of membership in kin or corporate groups. As shown in Figure 6.12B, copper beads and exotic lithic bifaces mediate access between females and juveniles independent of one another, suggesting that these different materials are associated with two separate groups that perhaps represent maternal and paternal kinship.

Male access to females and juveniles occurs at lower betweenness values indicating that, as in Reigh society, male competition is dominant in the Riverside community though juveniles and females more often display valuable symbols. Male access to females and juveniles is mediated through social positions represented by such material symbols as copper points and copper crescents (Figure 6.12D and E). In the Riverside community, males symbolize fitness with copper; females and juveniles use both copper and exotic lithics to indicate social position. However, whereas Reigh appears to feature adult male accomplishment and competition as a means of gaining social position, Riverside features relationships created through females and juveniles.

Discussion

Material goods are more than tools, ornaments, and debris. Many items of material culture are also symbols of beliefs, identities, values, and ideas—what Befu (1977) calls the *expressive* realm of material culture (see also Renfrew 2001; Robb 1999). Materials buried with individuals are a social validation and expression of the roles and identity that individual possessed in life (Goldstein 1980; Saxe 1970). Comparing those materials found in graves with those found in domestic contexts identifies a subset of goods that are more likely to express these qualities.

At Reigh, these expressive goods include items of copper, local lithics, antler and bone artifacts, and marine shell. Expressive lithics include large hafted bifaces found with one element of Reigh society that includes both adult males and females. These bifaces are made of local materials such as Galena chert, and their presence is not the result of long-distance relationships or specialized production, as shown in Chapter 5. Copper items are rare at Reigh, but twenty two copper feathers were found as a headdress with one individual, and twelve copper beads and three copper points were also present. Copper may be available locally in secondary glacial sources, or could have been obtained through interaction with communities farther north. Faunal elements of bone and antler appear to be associated with socially recognized identity within Reigh society—perhaps symbols of membership in age-grade societies or other sodalities. Reigh society uses these largely locally-available materials to symbolize to local audiences male social position gained through accomplishment. Juveniles lack such material symbols, and their importance in Reigh society more than likely reflects the success and accomplishment of males. Females are associated with males who exhibit the material symbols of higher social position. Indeed, an examination of the Reigh social network shown in Figure 6.2 shows that material symbols such as crane bills, copper feathers, juveniles, and number of interments per grave lie intermediate between males and females in the network, and thus these items (and the social position or accomplishment that they represent) mediate the relationship between males and females. Males with these symbols and social position have greater access to potential spouses and have higher reproductive opportunities than other males.

The presence of at least one female with exotic symbolic goods (marine shell beads and sandal-sole gorget) suggests that changes in this system were underway around 4000 years ago. Females with exotic goods may have been gained as spouses through exchange with more distant communities that built male connections and networks. Access to these connections would provide participating males with both the direct benefits of non-local resources, but also would help build relationships of obligation and position those males as brokers within their communities.

At Riverside, expressive material culture is dominated by copper and exotic lithics. Both have distinctive visual elements—copper with its metallic qualities and exotic lithics with distinctive colors, large size, and standardized characteristics—that facilitate their use as symbols capable of conveying information to large groups and make them ideally suited for signaling social roles and value. The faunal elements seen at Reigh are lacking, and grave goods are now interred largely with juveniles and females rather than males.

Riverside society seems to be a culmination of the humble beginnings seen with the shell beads and gorget at Reigh—expressions of access to distant communities have become primary features of Riverside symbolism. However, at Riverside it is the juveniles and females who are associated with symbols of high social value, not males. These symbols greatly emphasize or attract access to distant resources and relationships, and are largely manufactured from copper and exotic lithics. As shown in Chapter 5, the Wyandotte chert bifaces featured prominently as such symbols appear to have been produced by specialists in the Ohio Valley so as to convey meaning and information on the authenticity of the symbol across a wide geographic and cultural landscape. Other such symbols include copper beads, copper celts, copper points, and copper crescents. Wyandotte lithics at Riverside are markers of relationships somehow built over large social and geographic distances, while copper artifacts suggest access to copper resources that may attract potential exchange partners from those distant communities.

But what does this shift in social value from adult males to juveniles mean? Often, the appearance of high value grave goods associated with juveniles, who have not yet had time to acquire status through their own accomplishments, is interpreted as the development of ascribed status in which children are born into families and corporate groups that already have status and higher social position. Yet, with the exception of a few graves, status is not indicated in the otherwise egalitarian Archaic foraging societies of the upper Great Lakes. An alternate explanation uses the concept of *value*, not status, to explain the changes affecting Archaic society.

In this explanation, children and females do not have status in the sense of social hierarchies; instead they possess value. As Levi Strauss (1969), Mauss (2002), Gosden (1989), and others have noted, the exchange of material gifts creates relationships of trust and obligation. As discussed in Chapter Two, one understanding of exchange is based in the evolutionary theory of Reciprocal Altruism (Trivers 1971) in which trust is measured and established through a series of exchange events. As trust is established, Levi Strauss' (1969) *supreme gift* of women as spouses between exchange partners moves the relationship from one based in the establishment and maintenance of trust to one based on kinship and Hamilton's (1964) theory of Inclusive Fitness. When this point is reached, daughters become *valuable* assets to exchange partners as the means to create strong bonds and relationships with distant communities.

Williams (1969:166-169) noted that this valuation of daughters is linked to the creation of rules of exogamy. Since exchange brings opportunities for males to gain access to fitness enhancing resources and relationships, and the ultimate exchange is that of females, daughters are reserved for marriage and are valued for their potential to create and maintain relationships that channel resources between groups, build and maintain trust, and reduce potential hostilities.

To explore this explanation, it is important to recall that Reigh males gain additional social position upon achieving access to females (after marriage) and then later upon having children. Competition among males for access to females is conducted locally and more often between adult males rather than through arranged marriages between families. However, at Riverside, males may no longer be competing locally for females and reproductive opportunity, and their social position is no longer displayed in the same way or to the same audience. Riverside males likely gain access to social position through relationships created with other—potentially distant—communities through marriages arranged between children and symbolized by the exchange of gifts such as copper and Wyandotte bifaces. Females and juveniles take on additional value as important means to creating extra-community relationships and as symbols of male social position. As discussed earlier in this chapter, marriages in many historic native societies of the region were often arranged between families to build relationships, and could occur as early as infancy. The arrangement often involved the grooms family sending gifts to the bride's family—if accepted, the couple was betrothed (Buffalohead 1983; Densmore 1929; Duning 1959; Keesing 1939; Radin 1990; Skinner 1913). Similar arrangements may have been in effect during the Late Archaic, in which gifts consisted of standardized sets of Wyandotte bifaces and copper beads that signaled the value of the transaction or the resources available to one or both families.

We can thus propose that Riverside represents the culmination of a trend first seen at Reigh, where women and young children gain status from their role—potential or actualized—in the creation of bonds of trust and interaction between individuals in distant communities.

Exogamy rules may be in place at Riverside, along with some degree of group identity and boundaries that define exogamy in terms of community or corporate group. Earlier at Reigh, male accomplishment through activities within their community provided them enhanced reproductive opportunities. At Riverside, males gain reproductive advantage through relationships created through exchange—ultimately exogamous exchange of daughters and female relatives.

In this explanation, the material goods involved in exchange are best seen as items of symbolized *value*—they represent a standardized valuation or type of currency used in important transactions of balanced reciprocity, such as negotiations surrounding the arrangement of marriages. Exotic chert bifaces are manufactured to more precise standards of metrics, material and appearance to attest to their authenticity as well as to prevent cheaters from producing counterfeits and falsely gaining the benefits of exchange. Copper beads also verify their authenticity through their material of manufacture. Though not investigated here, it is possible that beads were exchanged through standardized numbers or lengths of strings of beads. The value of these materials is in the relationships and access to resources they symbolize—copper from Riverside, Wyandotte lithics from outside this community. If this is the case, the development of cultural systems such as Red Ocher represents standardized interaction between communities that feature rules of exogamy, changing valuation of females and juveniles as important elements for building interaction opportunities, increasing scale of competition for reproductive opportunities from local to regional, the building of social networks between communities through exchange and intermarriage, and the use of items of standardized symbolic value in the negotiation of important transactions. Through this perspective, we can see that the changes that characterize the difference between Middle Archaic societies such as Reigh, and

Late Archaic societies such as Riverside are due largely to two factors: 1) a change in the scale of male competition for mates from local to inter-community, and 2) changes in the valuation of females and juveniles that is a direct result of the increase in scale.

CHAPTER SEVEN

THE INTRODUCTION OF COPPER INTO REGIONAL EXCHANGE: COPPER ACQUISITION AND PRODUCTION AT THE DUCK LAKE SITE

In Chapter Five we saw that systems of regional interaction develop during the Late Archaic and encompass the area from Lake Superior to the Ohio Valley, while the previous chapter demonstrated that such interaction involved the exchange of semantically charged items made of exotic lithics and copper. Exchange systems expand greatly during the Late Archaic, mortuary ritual elaborates and is shared across a wide region, standardized symbols are created which convey information across great distances, and interaction between societies takes both positive and negative forms with the appearance of clear examples of interpersonal violence and warfare.

Copper is prominently featured in the regional systems of both exchange and symbolism. Yet while copper has long been of interest in the archaeology of the upper Midwest and Great Lakes, an understanding of the role of copper procurement and exchange within the Late Archaic societies of the region has been slow to develop. How was copper acquired and entered into this regional system? Recent research in the southern Lake Superior basin has begun to open approaches to studying Late Archaic societies and their mobility, resource acquisition, and exchange, and to examine copper procurement and production within these larger issues. In this chapter, one such site is examined in depth, and lithic analysis is used to address issues of resource procurement and group mobility.

Previous research concerning copper has focused on broad morphological studies (Wittry 1951; Hedican and McGlade 1993), mortuary occurrences (Hruska 1967; Pleger 1998), sourcing and trace element analysis (Pletka 1991; Rapp 1980, 2000), and detailed metallurgical studies (Vernon 1990). Exchange systems involving copper have been used to address the emergence of social complexity and the formation of social networks (Bender 1985; Brown 1985). Copper studies have even played a role in the development of systems and processual theory in archaeology (Binford 1962). What has been lacking from this discussion is a clear understanding of how, where, and by whom copper was acquired, the nature of copper production, and the means by which copper was introduced into systems of regional exchange.

One approach to this issue is to examine the distribution of copper through the region to understand both the nature of production, source of distribution, and types of interactions responsible for the movement of this resource through space. Working in the bronze age Aegean, Renfrew (1972:465-471) proposed four models of exchange systems that focused on the methods and control of exchange systems and the ultimate spatial distribution of goods. These include down-the-line exchange, the prestige chain, free-lance commercial trade, and directional trade. Down-the-line exchange systems are the result of numerous small exchanges between neighboring groups over time. Exchange is most likely characterized by Sahlins's (1965, 1972) generalized or balanced reciprocity, and occurs between individuals already related through kinship or tribal membership. The exchanged materials are common on sites near the source, and their frequency declines exponentially with distance from the source. This model fits best with materials that are consumed through utilitarian functions or adornment (Renfrew 1972:466-467). The exchange of non-utilitarian prestige goods through systems such as the Kula Ring (Malinowski 1932) is defined by the prestige chain model, in which prestige items are exchanged between notable persons, are frequently circulated and recirculated, and often appear in the archaeological record as a result of deliberate burial or accidental loss rather than through consumption. The distribution of goods in this model is similar to the down-the-line model, with two exceptions. First, prestige goods are typically not as common as consumables, and second the fall off curve is not as steep as goods are circulated widely over a large area. Both of the preceding models feature multiple transactions over time and space. Commercial trade, however, involves interaction with strangers, covers considerable distances, and may involve trade specialists and middlemen. The free-lance commercial trade model describes this particular form of trade. The distribution of goods under freelance commercial trade consists of an abundance of material near the source, and a relative abundance within a broader area that corresponds to the trader's activity area. Outside this zone, the abundance of exchange materials declines rapidly as other exchange methods come to predominate. Finally, directional trade models feature the preferential acquisition of goods at some distance from their source. As a result, some sites at a distance from the source area may have more of the material than closer sites. Such exchange systems are directional—they feature the regular movement of goods from one location to another distant location at which those items are preferentially acquired. Graphing the distribution of goods under such a system would show an abundance near the source, a fall off curve with declining abundance with distance, and notable peaks in abundance at distances corresponding to locations of preferential acquisition.

In the Midcontinent, copper distribution and exchange was first explicitly studied by Fogel (1963). Documenting the known locations and quantities of copper in sites of the upper Midwest, Fogel found that copper was most common from 100 to 200 miles (160 to 320 km) from the Keweenaw source and largely absent within 100 miles (160 km) of the source (Figure 7.1). Copper frequencies generally declined from 200 to 400 miles (320 to 640 km), then dropped precipitously around 450 miles (725 km) and remained relatively constant beyond that point. He then concluded that copper was preferentially obtained by populations located some distance from the source area, perhaps centered on the Riverside site. Exchange then closely fit the directional-trade model developed by Renfrew (1972).

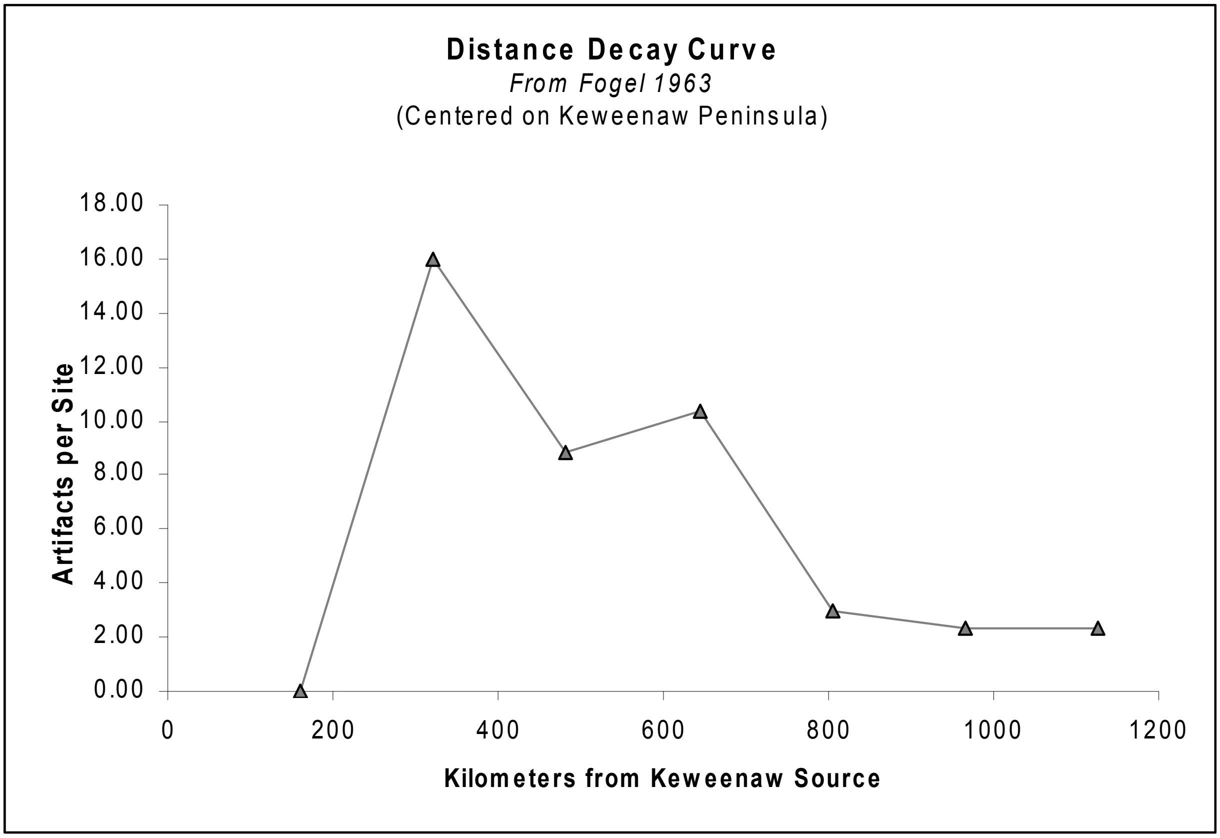


Figure 7.1. The distribution of copper materials in sites of the upper Midwest as a function of distance from the Keweenaw source area, after Fogel (1963)

Two obvious omissions have caused archaeologists to question these results. First, archaeological research has preferentially focused on areas farther from copper sources while areas closer to the source have (until recent years) received less attention (Martin 1999:198-199). The resulting bias in the frequency of copper could produce a distribution that mimics preferential and direct acquisition from a distance. Second, Fogel's study ignores any potential differences in population density that may have existed from north to south in the Archaic Great Lakes, and the consequences of such variability in the deposition of copper in the archaeological record. Chapter Four demonstrated that the population density of the region is far from uniform, and that areas close to the copper source featured low population density compared with the

Lake Winnebago region, Green Bay shore, or the Mississippi Valley. Such differences in population density would result in greater frequencies of copper in those areas of higher population, even if copper was ubiquitous in sites close to the source.

More recently, Clark (1995) has demonstrated that copper acquisition on Isle Royale was embedded in a broader set of subsistence related activities. The direct procurement model endorsed by Fogel thus begins to give way to perspectives that favor embedded procurement and exchange systems emphasizing down-the-line models. As a result of the limitations of Fogel's data and recent research on mobility and resource acquisition on the Lake Superior north shore, most archaeologists today favor down-the-line models to account for the acquisition and distribution of copper.

A quick review of the frequency of copper, as a percentage of the total assemblage, from five sites supports this modified view (Figure 7.2). Individual components were used, rather than an overall total of recorded copper, to minimize the effects of variation in population density and research bias. This approach shows that copper declines exponentially with distance as measured at the Riverside site, Reigh site, Price III site, the Red Ocher Mound F^{o}11 at Morton Mounds in the central Illinois Valley (Cole and Deuel 1937), and Klunk Mound 7 in the lower Illinois Valley (Perino, 1968). In this example, the source is taken as the southern Keweenaw Peninsula in the Lake Superior Basin, which is the closest primary source to all five sites. Unlike Fogel's data, this graph highlights the fact that the areas closer than 200 kilometers to the primary copper sources are underrepresented in our analysis.

Thus the areas closer to copper sources become critical to understanding copper acquisition and exchange. Does copper fit the down-the-line model of frequent small-scale interactions between neighbors, or is if preferentially obtained by populations outside the source area? Within the Midcontinent, that source area is largely limited to the Lake Superior region (Figure 3.4) where copper is concentrated along the Keweenaw Highlands in the southern basin, and Isle Royale, the Minnesota and Ontario north shores, and Michipicoten Island in the northern basin (Martin 1999:25-30; Rapp 2000).

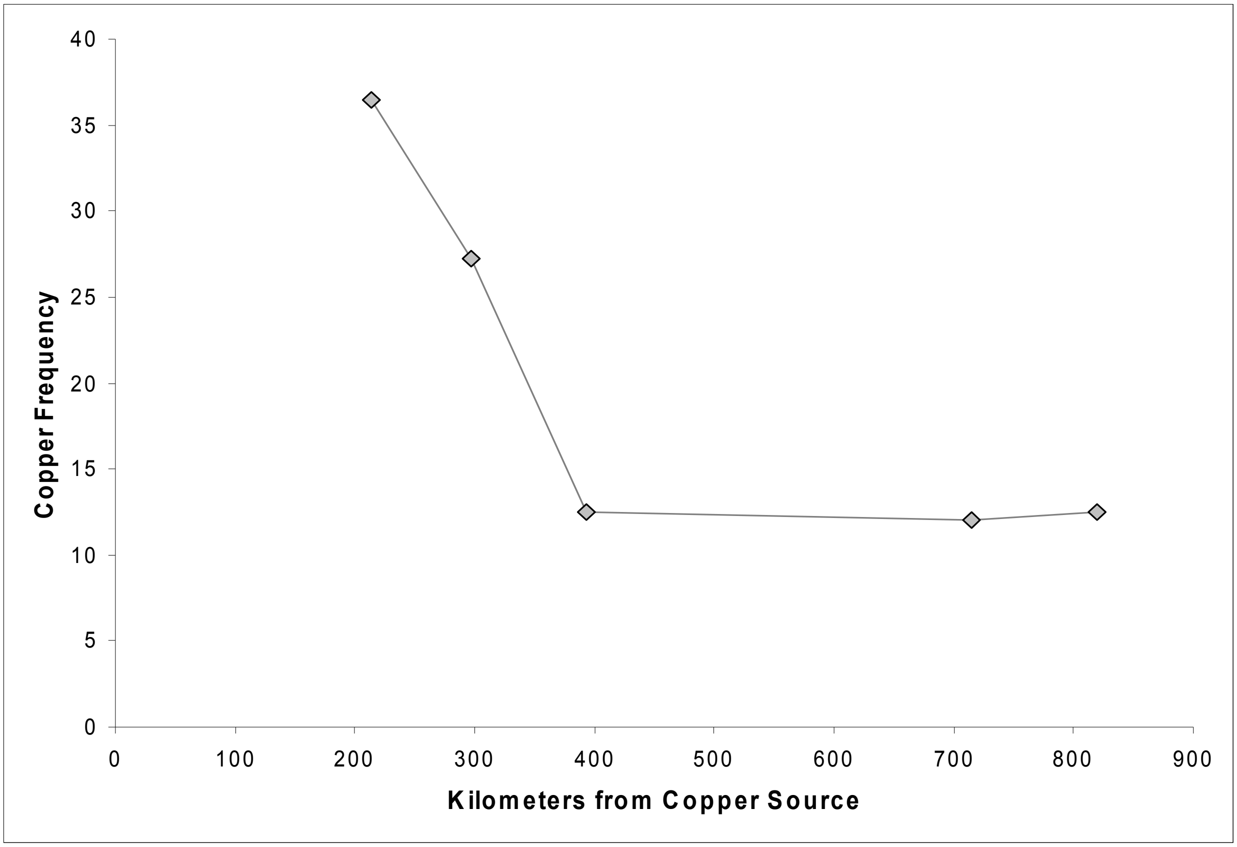


Figure 7.2. Assuming that data from within 200 km of the Keweenaw copper source is lacking or biased, the frequency of copper, as measured as a percentage of the total assemblage, is shown to decrease exponentially with distance from the copper source. Five sites are included: from left to right, Riverside, Reigh, Price III on the lower Wisconsin River, and Mound F^{o}11 at the Morton Mounds and Klunk Mound 7 in the Illinois Valley.

Archaeological research in this area has been uneven. While survey and testing of Isle Royale have revealed several Woodland and some Archaic period copper procurement locations, the Archaic components align more closely with north shore cultural developments than those of

Michigan and Wisconsin to the south (Clark 1996:132). In the southern basin, historic mining and development along the Keweenaw Highlands damaged or destroyed many sites in the nineteenth century thus limiting the number of intact sites available for research. Furthermore, the western Upper Peninsula of Michigan received little archaeological attention prior to the inception of cultural resource management activities during the past few decades. The historically limited number of excavated components that relate to Archaic period procurement and processing of copper in the southern basin, and further south in Wisconsin, Michigan and surrounding states, is partially a result of these historical factors.

However, recent research at several sites in the western Upper Peninsula and adjacent northern Wisconsin put researchers on the threshold of these issues. Several sites in the Northern Highlands and Keweenaw Peninsula, many of which belong to the Burnt Rollways phase, have now revealed Late Archaic components in which copper was either obtained or processed (Hill 2005; Martin 1993; Moffat and Speth 1999). One of these sites, Duck Lake, contains a discrete Late Archaic component directly related to copper acquisition and processing.

In this chapter, important social aspects of copper acquisition and production at the Duck Lake site are described. The cultural affiliation of those involved in copper acquisition and use production is determined; lithic analysis is used to explore mobility strategies, site function, and interaction with others within and outside the region; and methods of copper acquisition and production are described. The results are then combined with data from other sites from the Northern Highlands to the Illinois Valley to better understand the nature of Late Archaic production, exchange, and social interaction that distributed this one important resource through the Midcontinent.

The Duck Lake Site

The Duck Lake site is located in Ontonagon County, Michigan along the East Branch of the Ontonagon River (Figure 7.3). The site lies approximately 22 kilometers south of the Keweenaw Highlands, or Trap Range, and approximately 50 kilometers upstream from Lake Superior in an area of generally low relief and sandy soils. The East Branch of the Ontonagon River flows through a deeply entrenched valley to the north and east of the site, while Duck Lake and a series of small marshy ponds are located immediately south of the site. On-site vegetation is largely pine, with lesser quantities of maple, birch, and aspen and an understory dominated by bracken fern, wintergreen, and blueberry.

Late Pleistocene and early to mid-Holocene glacial and postglacial events are responsible for much of the modern landscape. Glacial advances deposited a terminal moraine immediately north and northeast of the site, while remnants of other terminal moraines are located south and east of the site. This glacial advance blocked drainage in the area, forming proglacial Lake Ontonagon between 10,500 and 11,000 BP (Farrand and Drexler 1985). As the glacial lobe subsequently receded, Lake Ontonagon drained northward and melt water from the receding ice-sheet carried fine sandy sediments that were deposited over the clay lakebed soils around the eastern edge of the Lake Ontonagon plain and the margins of the rockier moraines. An early stage of the East Branch of the Ontonagon River flowed over one of these outwash plains as it drained northward to Lake Superior.

As the glaciers receded, lake levels of the newly formed Lake Superior dropped to levels up to 180 feet below modern by about 9,500 RCYBP (Farrand and Drexler 1985, Fitting 1975:11-18). This significantly lowered the base level for the rivers of the region, and the East Branch of the Ontonagon River eroded through the fine sandy sediments of the outwash plains and the denser clay lakebed soils to form an entrenched meandering river (Haywood 1998:8). Lake levels subsequently rose to approximately 20 feet above modern during the Nipissing transgression around 4500 BP, thus reducing the rate of downcutting and resulting in the deep steep-sided gorge through which the river currently flows.

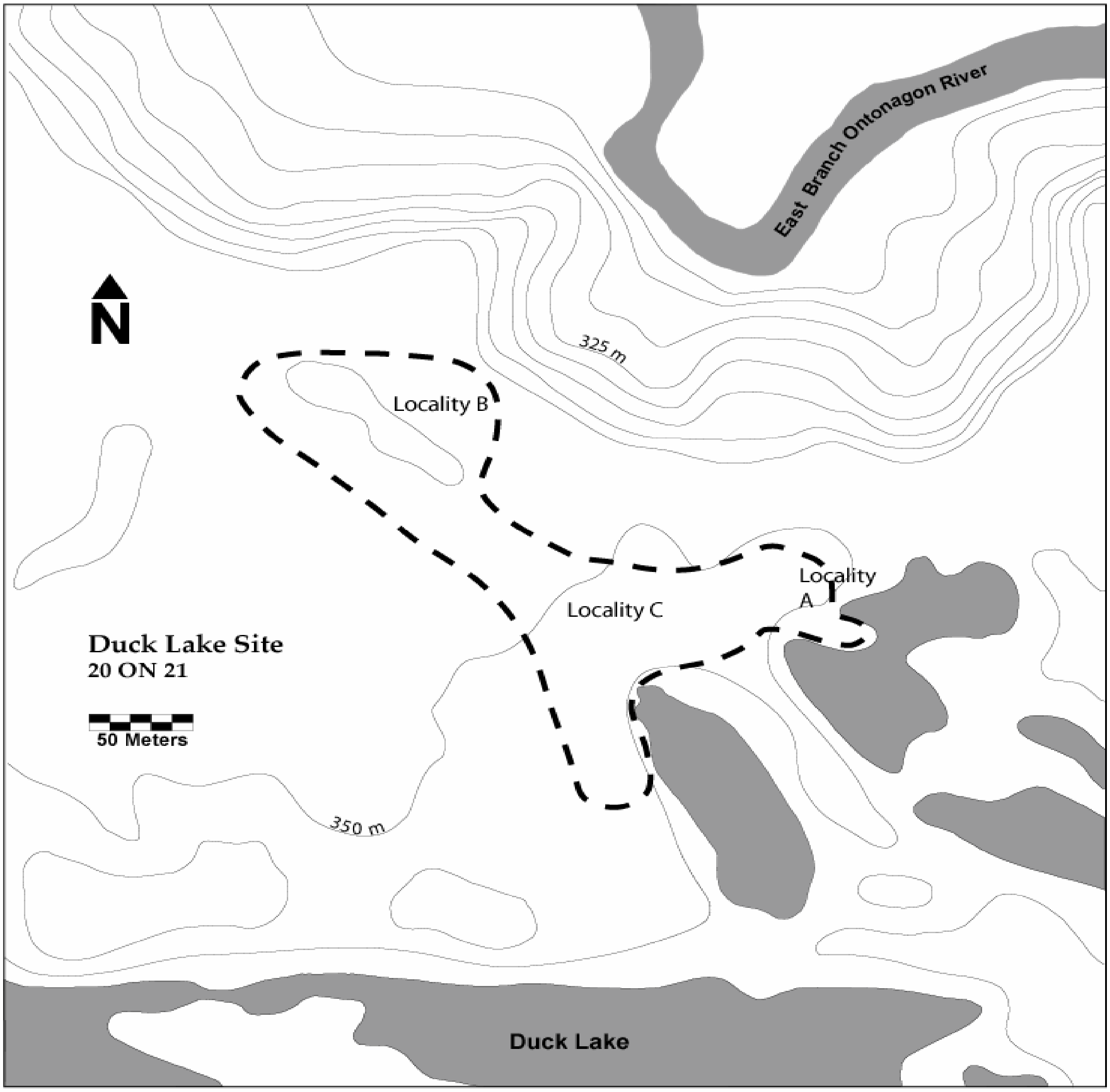


Figure 7.3. The Duck Lake Site

The Duck Lake site is located on one of the sandy outwash plains, while the entrenched East Branch of the Ontonagon forms a deep gorge along the eastern and northern margins of the site. A large terminal moraine with its rockier soils and higher relief is located on the opposite side of the river from the site (Figure 7.4).

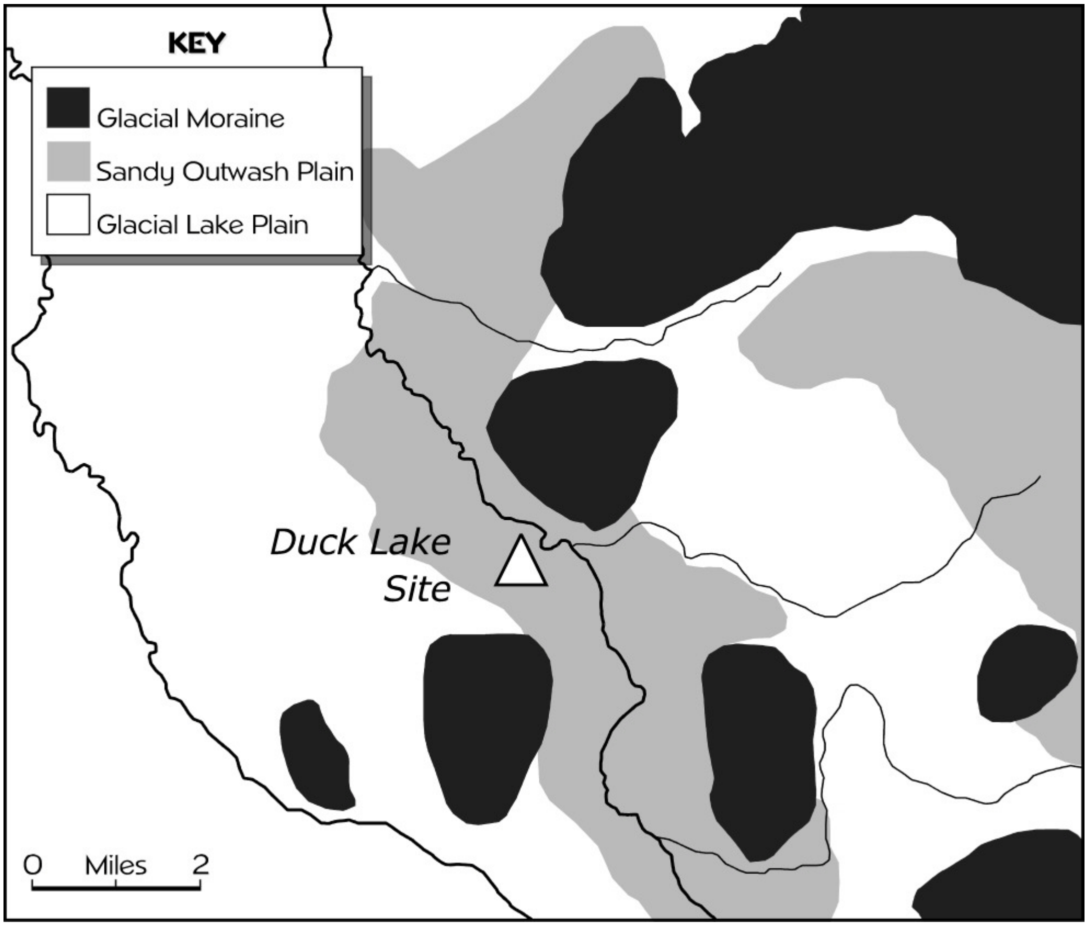


Figure 7.4. Surficial glacial geology in the vicinity of the Duck Lake site.

The site was originally discovered by collectors who noted the presence of cultural material on the surface of two dirt roads that cross the cultural deposit's northwestern and eastern portions. Mapping of the archaeological deposit later revealed three areas, localities A, B, and C, where cultural material appeared to be concentrated (Figure 7.3). Locality A is a small southward projecting peninsula on the shore of one of the small ponds. Locality B occupies a low ridge overlooking the river to the northeast, while Locality C is located between A and B at the intersection of two of the dirt roads and along the north and west shore of another of the small ponds on the southwestern part of the site.

Formal investigations began in 1994, when archaeologists with the Ottawa National Forest conducted a systematic shovel-testing project to document site boundaries and determine the nature of the cultural deposit. In 1996 and 1997, Ottawa National Forest archaeologists and volunteers under the Forest Service's Passport in Time program returned to the site to conduct limited excavations within Locality B (Figure 7.5). Twenty-eight square meters were opened, mostly within a five-meter square block excavation centered on an area of lithic and copper concentration that had been identified through shovel testing. All excavation was conducted by hand troweling in three-centimeter levels, fill was screened through ¼ inch mesh, and all artifacts found during excavation were piece plotted before removal.

Controlled metal detector surveys were conducted to identify areas of copper concentration. An attempt was made to distinguish between recent metal artifacts such as bullets and beverage can tabs and prehistoric copper artifacts. Copper artifacts were flagged and mapped as they were encountered and most were not excavated. However, copper artifacts along the dirt road on the south side of Locality B were recovered after mapping as collectors and metal detector enthusiasts have traditionally exploited this area.

Excavation revealed a relatively straightforward alfisol, based upon a parent material of fine, well-sorted sand. A thin organic horizon, consisting of a mat of decaying leaf litter and plant material, extended from the surface to a depth of between one and two centimeters. A four to five centimeter thick dark gray sandy loam *A* horizon was located beneath the organic *O* horizon. A thicker eluvial strata of light grayish brown to pinkish gray sandy loam, varying from 8 to 18 centimeters in thickness, was found beneath the *A* horizon. Finally, the transition from the light grayish brown *E* horizon to the underlying strong brown finely sorted sands of the *B* horizon was pronounced and readily observed.

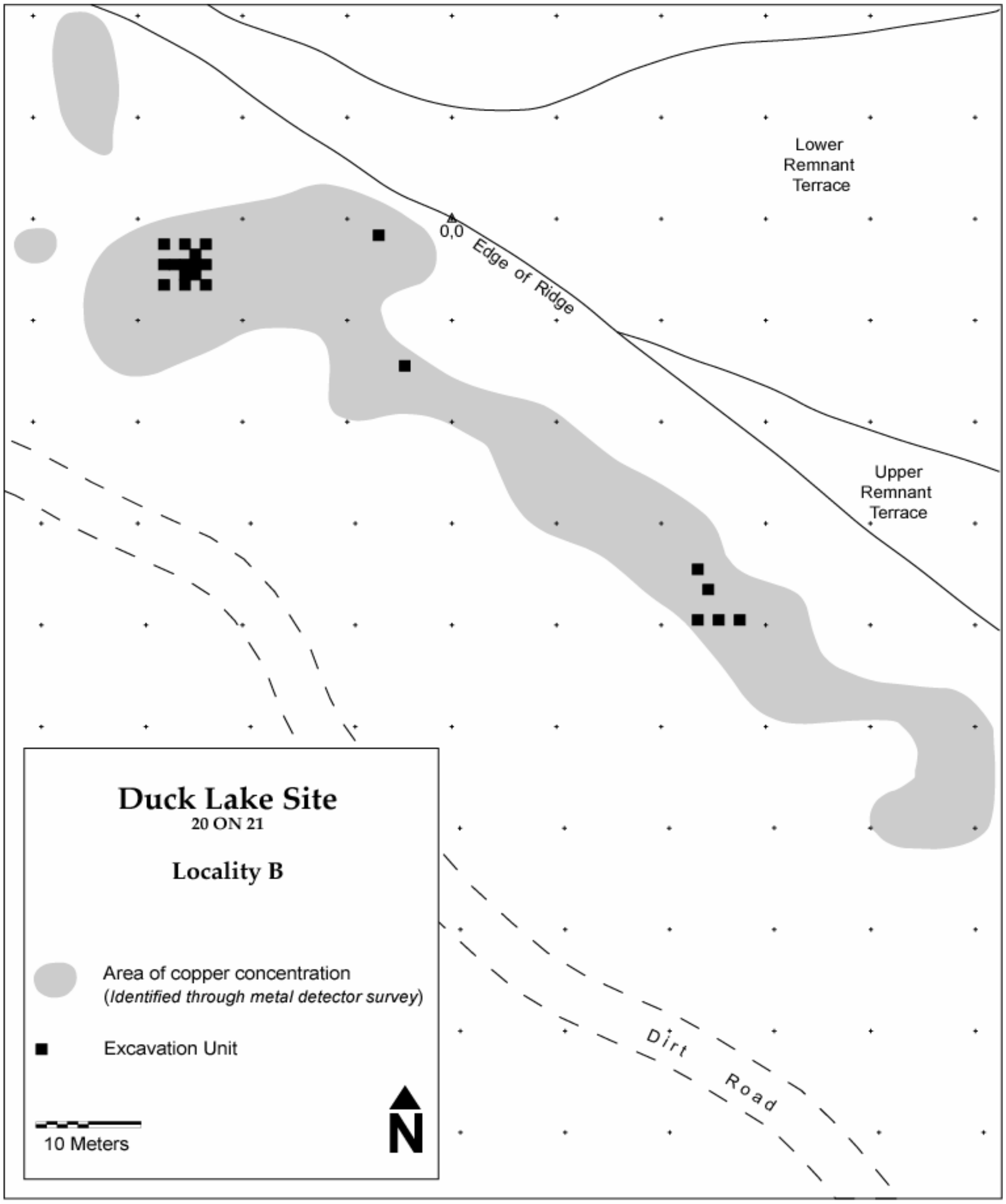


Figure 7.5. Excavation units and copper distribution at Locality B.

The cultural deposit began at the base of the *A* horizon and was most commonly associated with the light colored sandy loam soils of the *E* horizon. Cultural material was found in a single cultural stratum that began around 12 centimeters below surface and extended to a maximum depth of 32 centimeters. Cultural material frequency diminished rapidly at the bottom of the *E* horizon and materials were largely absent from the fine sands of the underlying *B* horizon.

Features

Three features were identified, including two unprepared surface hearths and a concentration of copper artifacts and scrap (Table 7.1). All three were found near the center of the block excavations in Locality B. Feature A was a poorly defined area of charcoal staining and reddened soil found at a depth of 18 centimeters below surface. No pit was identified, and the feature is interpreted as a surface hearth. Materials associated with this hearth include worked copper nuggets, copper preforms, a corner-notched projectile point fragment, and Prairie du Chien and Galena chert debitage. One wood charcoal sample was recovered from this feature for radiocarbon dating. A 3.5-liter soil sample was collected from Feature A and submitted to the Museum Archaeology Program, State Historical Society of Wisconsin, for flotation and analysis. Wood, bark, charcoal, and other floral remains were recovered from the sample after sorting under 10x binocular magnification. Identified taxa include wood charcoal from maple, spruce, red pine, white pine, and red oak (Table 7.2). One seed of bittersweet and one unidentifiable seed were also identified.

A second hearth, Feature B, was found approximately 140 centimeters south of Feature A starting at a depth of 18 centimeters below surface and extending to 24 centimeters. This was a well-defined oval surface hearth with charcoal, charcoal staining, reddened soils and fire-cracked rock. Approximately half of the feature was excavated; the other half extended into the west walls of the excavation unit. A worked copper nugget rested on the pitted upper surface of an anvil stone three centimeters east of the feature. Other materials in association included lithic debitage of Prairie du Chien and Galena cherts and worked copper scrap. A seven-liter soil sample was taken from the hearth and submitted for flotation and analysis. This produced 778 pieces of botanical material (Table 7.2). Most consisted of wood charcoal, including species such as maple, spruce, pine, and red oak.

Table 7.1. Duck Lake Features

Feat.	Type	Shape	Dimension	Associated Material
A	Hearth	Irregular Oval	32 x 10 cm	Worked copper, copper performs, debitage
B	Hearth	Oval	57 cm	Anvil stone, worked copper, debitage
C	Artifact concentration	Irregular	40 x 20 cm	Worked copper, bone, lithics

A small concentration of worked copper, fragmentary bone, and lithics was found between the two hearths at a depth of 20 centimeters below surface and labeled Feature C. The purpose and formation process of this feature are not clear; it may represent a small activity area, or it could be the result from the cleaning of one of the nearby hearths. A soil sample was recovered from the area around this feature and again submitted for flotation and analysis. Botanical materials found in association with this feature include wood charcoal from white pine, red oak and unidentified coniferous species, along with one maple seed and an unidentified seed (Table 7.2).

Table 7.2. Duck Lake site botanical material recovered through flotation of feature fill.

Provenience	Flot	Ct.	Wt. (g)	Charcoal									Seeds (ct)			Other	
	Volume (liters)			*Acer* sp.	cf. *Picea* sp.	*Pinus* sp.	*P. resinosa*	*P. strobus*	*Quercus* sp. (Red Oak Group)	Coniferous	Diffuse Porous	Unidentifiable	*Acer* sp.	*Celastrus scandanens* (Bittersweet)	Unidentifiable	Herbaceous Stem (ct)	Unidentifiable Organic (ct)
Feature A	3.5	210	2.51	2	1	1	1	1		11		3		1	1		24
Feature B	7.0	778	6.10	2	3				2	10	1					6	29
Feature C	4.0	240	2.61					2	1	10		7	1		1	1	19

Excavation also produced 155 small highly fragmentary, mostly burned, pieces of bone (Table 7.3). These all appear to represent mammal species, but most are unidentifiable. One fragment represents a long bone of a raccoon-to-deer size mammal, while a second is a right phalanx of a fisher or marten sized mammal. Identification of genus and species was not possible for any of this material.

Radiocarbon Dates

Two charcoal samples were collected for radiocarbon dating. The first was wood charcoal collected from a depth of 24 centimeters below surface near the base of Feature A. Accelerator mass spectrometry (AMS) analysis of this sample produced a conventional C14 age of 3420 ± 50 RCYBP (Beta 099777). Calibration of this date using the Pretoria Calibration Procedure (Vogel et al. 1993) yielded an intercept date of 1705 BC and a 1σ intercept range of 1755 to 1660 BC.

Table 7.3. Faunal Material

Acc. No.	Taxonomy	Element	Weight (g)	Burning	Count	Comments
324	Mammal	NID	7.3	Calcined	52	
324	Mammal	NID		No	14	
324	Mammal	NID		Blackened	1	
324	Marten/Fisher	Phalanx	0.1	Calcined	1	
325	Mammal	NID	1.7	Calcined	7	
325	Mammal	NID		1/2 Calcined	5	
325	Mammal	NID		1/2 Calcined, 1/2 Blackened	1	
325	Mammal	NID		No	1	
328	Mammal	NID	1.3	Calcined	12	
328	Mammal	NID		1/2 Calcined	5	
331	Mammal	NID	0.6	1/2 Calcined	1	
331	Mammal	NID		1/4 Calcined	2	
334	Mammal	NID	0.2	Calcined	1	
334	Mammal	NID		1/2 Calcined	1	
336	Mammal	NID	1.1	Calcined	13	
336	Mammal	NID		Calcined and 1/3 Blackened	1	
336	Mammal	NID		Calcined	1	Articular Surface
337	Unidentified	NID	0.5	Calcined - blueish	6	
557	Mammal	NID	0.1	Calcined	1	
572	Raccoon/Deer	Long bone	0.8	Calcined	1	
572	Mammal	NID	0.4	Calcined	2	
603	Mammal	Cranial	1.1	No	1	
603	Mammal	Cranial	0.1	No	1	
657	Mammal	NID	0.4	Calcined	6	
697	Mammal	NID	0.3	Calcined	2	
700	Mammal	NID	2.0		10	
700	Mammal	NID	0.1	Calcined	1	
716	Mammal	NID	0.1	1/4 Calcined	1	
731	Mammal	NID	0.9	No	2	
731	Mammal	NID	0.3	No	1	
743	Mammal	NID	0.2	Calcined	1	Articular Surface
Totals			19.6		155	

The second sample was taken from a depth of 17 centimeters below surface immediately north of Feature B. It was found in association with an area thought to represent the production of copper artifacts. Materials associated with the charcoal sample include copper scrap, an anvil stone, lithic debitage, and fire-cracked rock. This wood charcoal sample was submitted for extended counting which produced a conventional age of 3400 ± 110 RCYBP (Beta 124454). Calibration yielded an intercept date of 1685 BC, and two ranges within the 1σ probability; 1870 to 1830 BC, and 1780 to 1530 BC.

Excavation within Locality B suggests that this part of the extensive site consists of overlapping small activity areas or components. The compressed stratigraphy of the site did not allow for separation of components. Nonetheless there is an impression of spatially distinct clusters of material that may represent separate contemporary groups or different occupations of the site. One or perhaps two of these activity areas are represented in the five-meter square block excavation, where the two hearths served as the focus of activities, and lithic tools, debitage, and copper artifacts were densely concentrated within two meters of these features (Figure 7.6).

Lithic Analysis

Stone tool and debitage assemblages are sensitive to group mobility and the availability of raw material (Andrefsky 1994; Bamforth 1986; Binford 1979). Binford (1979) proposed that high mobility correlates with a "curated" lithic assemblage featuring bifaces and other formal tools, while higher sedentism correlates with assemblages featuring expedient tools such as utilized and retouched flakes. The correlation between bifaces and mobility is related to the ability of bifaces to function both as tools and as a source of material for the production of other tools (Kelly 1988), while expedient tools are seen as more efficient in sedentary contexts since less energy is expended in their production.

Since its introduction, the concept of a "curated" lithic assemblage has undergone considerable discussion and debate (e.g., Andrefsky 1994; Bamforth 1986; Shott 1996). The availability of raw material has been determined to affect the efficiency of expedient tools (Bamforth 1986), while Shott (1996) has proposed that "curation" is not a nominal value, but

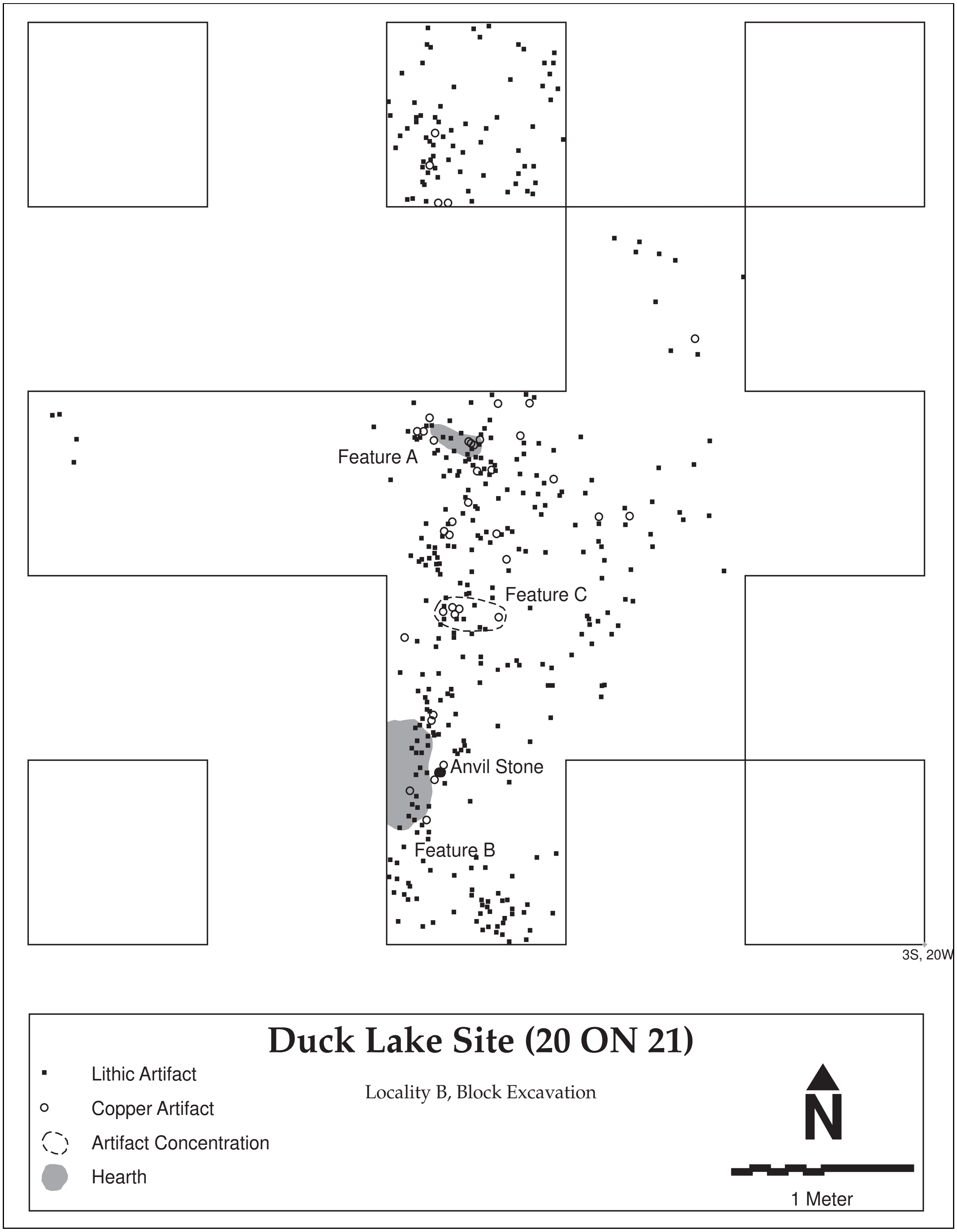


Figure 7.6. Features and activity areas associated with the block excavations in Locality B.

rather a continuous one best applied to individual artifacts in terms of the degree of utility extracted from the tool.

Several aspects of the Duck Lake lithic assemblage are thus examined to explore issues of mobility and exchange. These include identification of lithic raw material types to examine source areas and potential differences in assemblages composed of different materials; frequencies of expedient versus formal tools; a measure of "degree of utility extracted" for formal tools; and examination of debitage attributes such as flake type, debitage size, frequencies of biface thinning flakes, and platform types to understand reduction strategies and their variance based on raw material types.

Raw Materials

The vast majority of Duck Lake's lithics were of non-local materials such as Prairie du Chien chert, Galena chert, Knife River flint and Onondaga chert. This assemblage stands in marked contrast to other Late Archaic sites in the Lake Superior and northwestern Lake Michigan drainages, where locally available quartz typically dominates the assemblage (Salzer 1974; Hill 1994).

As discussed in Chapter Three, high quality lithic materials are limited in the southwestern Lake Superior basin. In the western Upper Peninsula and adjacent northern Wisconsin, quartz is the most commonly encountered lithic material in archaeological contexts dating from the Archaic period until the advent of European trade materials in the historic period. Hudson Bay Lowland chert is also available along streambeds, lakeshores and in glacial till. This material is of highly variable quality, and has been glacially deposited from a source north of Lake Superior. Basalt is also present, and was occasionally used for tool production in the area.

Most of the Duck Lake tools and debitage were produced from raw materials found outside of the Lake Superior basin (see Figures 3.6 and 3.7). Several different lithic materials occur in nearby northeastern Minnesota, including Knife Lake siltstone, Gunflint silica, and jasper taconite, yet none of these north shore materials occur in the Duck Lake lithic assemblage. Instead, the assemblage seems to have its primary sources to the south as represented by significant quantities of Prairie du Chien and Galena cherts from the lower Wisconsin River (Klawiter 2001), and lesser quantities of Hixton Silicified Sandstone from the west central Wisconsin (Bozhard 1998; Porter 1961). Other lithic materials at the site originate well outside the Lake Superior Basin, including Knife River Flint (KRF) from 700 miles to the west in western North Dakota (Clayton et al. 1970) and Onondaga chert from 500 miles to the east in the Lake Ontario region of New York and eastern Ontario (Hammer 1976; Wray 1948).

To identify these materials, lithics were first sorted into raw material classes by visual characteristics. Comparative collections of several lithic materials from the Midcontinent were then used to visually identify many of the lithics (see Chapter Eight for a detailed discussion). Additional analysis was performed to definitively identify Knife River Flint and Onondaga chert. Instrumental neutron activation analysis (INAA) was performed at the University of Toronto's SLOWPOKE Reactor Facility on twenty-eight debitage samples that were selected from the Duck Lake assemblage to represent the variety of materials found at the site (Bury 1997). Reference material for INAA was only available for Knife River Flint, Hudson Bay Lowland chert, and Onondaga chert. Chemical composition verified the initial visual identification of Onondaga and Knife River Flint. The remaining samples were visually identified as materials for which no comparative samples were then available for INAA, including Prairie du Chien and Galena cherts.

Overall, most tools were manufactured from non-local materials, principally Prairie du Chien chert, Galena chert, and Knife River flint (Table 7.4). Local lithics, including quartz and Hudson Bay Lowland chert, are represented but are in the minority. Local materials were largely used in the production of cores and expedient tools, although two cores are of Prairie du Chien chert.

Non-local materials also dominate the debitage assemblage (Table 7.5), most of which consists of Prairie du Chien and Galena cherts. Knife River flint, Hixton Silicified Sandstone, and Onondaga chert are also represented in minor quantities. Local materials make up less than twelve percent of the debitage assemblage, and are represented by quartz, Hudson Bay Lowland chert, and basalt. The remainder consists of unidentified cherts and quartzites that may represent both locally available lithics and non-local materials.

Table 7.4. Tools by lithic material (n=97)

Source Category	**Material**	**%**
Non Local		
	Prairie du Chien Chert	52.1
	Galena Chert	11.5
	Onondaga Chert	1.0
	Knife River Flint	4.2
Local		
	Quartz	11.5
	Hudson Bay Lowland Chert	4.2
	Sandstone	1.0
Unidentified		14.5

Table 7.5. Debitage by lithic material type (n=716)

Source Category	Material	%
Non Local		
	Prairie du Chien / Galena Chert	78.6
	Onondaga	0.3
	Knife River Flint	0.8
	Hixton Silicified Sandstone	0.4
Local		
	Quartz	8.8
	Hudson Bay Lowland Chert	3.6
	Basalt	0.1
Unidentified		7.3

Lithic Tools

Twenty-one formal tools (Table 7.6), including projectile points, drills, scrapers and bifaces, along with seventy-six expedient tools such as utilized and retouched flakes were recovered during formal investigations at Duck Lake. Two projectile point base fragments were recovered (Table 7.6), representing one small corner-notched point (Figure 7.7a) and one stemmed point. Both were manufactured from Prairie du Chien chert.

Scrapers are most commonly small thumbnail shaped endscrapers made on flakes (Figure 7.7g-l). Five are manufactured from Prairie du Chien chert, while the sixth is made from an unidentified gray chert. Bifaces tend to be fragmented and small. When determinable, bifaces are either oval or irregular in shape. A few complete and several fragmentary specimens are present in the collections (Figure 7.7e-f). One is manufactured from locally available quartz, while the rest are of identified non-local materials or unidentified chert.

Two fragmented Prairie du Chien chert drills from the Duck Lake site are thin, narrow bifaces and exhibit both lenticular and diamond-shaped cross sections (Figure 7.7b-c). A third drill was manufactured on a flake of Knife River Flint and exhibits side notches that appear to have facilitated hafting (Figure 7.7d).

Table 7.6. Formal Lithic Tools

Tool Type	Whole/ Fragment	Comments	Material	Wt (g)
Biface			Galena	12.00
Biface			Unidentified	2.30
Biface	Fragment		Unidentified	0.30
Biface	Fragment		KRF	2.70
Biface	Fragment		PDC	
Biface			PDC	6.00
Biface	Fragment		Quartz	3.40
Biface			Unidentified	12.20
Biface	Fragment	Tip	HBL	2.50
Biface	Fragment	Tip	Onondaga	0.90
Drill	Fragment		KRF	1.80
Drill	Fragment		PDC	1.00
Drill	Fragment		PDC	0.90
Proj Point	Fragment	Stemmed	PDC	1.60
Proj Point	Fragment	Corner notched	PDC	0.70
Scraper			Unidentified	1.80
Scraper			PDC	2.50
Scraper			PDC	3.20
Scraper	Fragment		PDC	0.50
Scraper			PDC	7.90
Scraper			PDC	3.80

Most formal tools appear heavily used, broken, and worn, as would be expected from an assemblage of curated tools at the end of their use life. The degree of “utility extracted” (Shott 1996) can be estimated using the “scraper index” developed by Kuhn (1991:82). This index measures the maximum centerline thickness of a scraper and compares it to the maximum vertical thickness of the working edge, and thus provides a relative measure of the remaining utility of the tool in which a value of zero represents unmodified flakes and one indicates tools that are extensively reduced and exhausted. The scrapers from Duck Lake are all manufactured of non-local material, and their scraper index averages 0.96 (range = 0.8 to 1.0, s.d. = .07, n = 6) thereby indicating that these tools have neared the end of their utility. In other words, the scrapers and, by extension and visual confirmation, many of the non-local tools are highly worn and depleted.

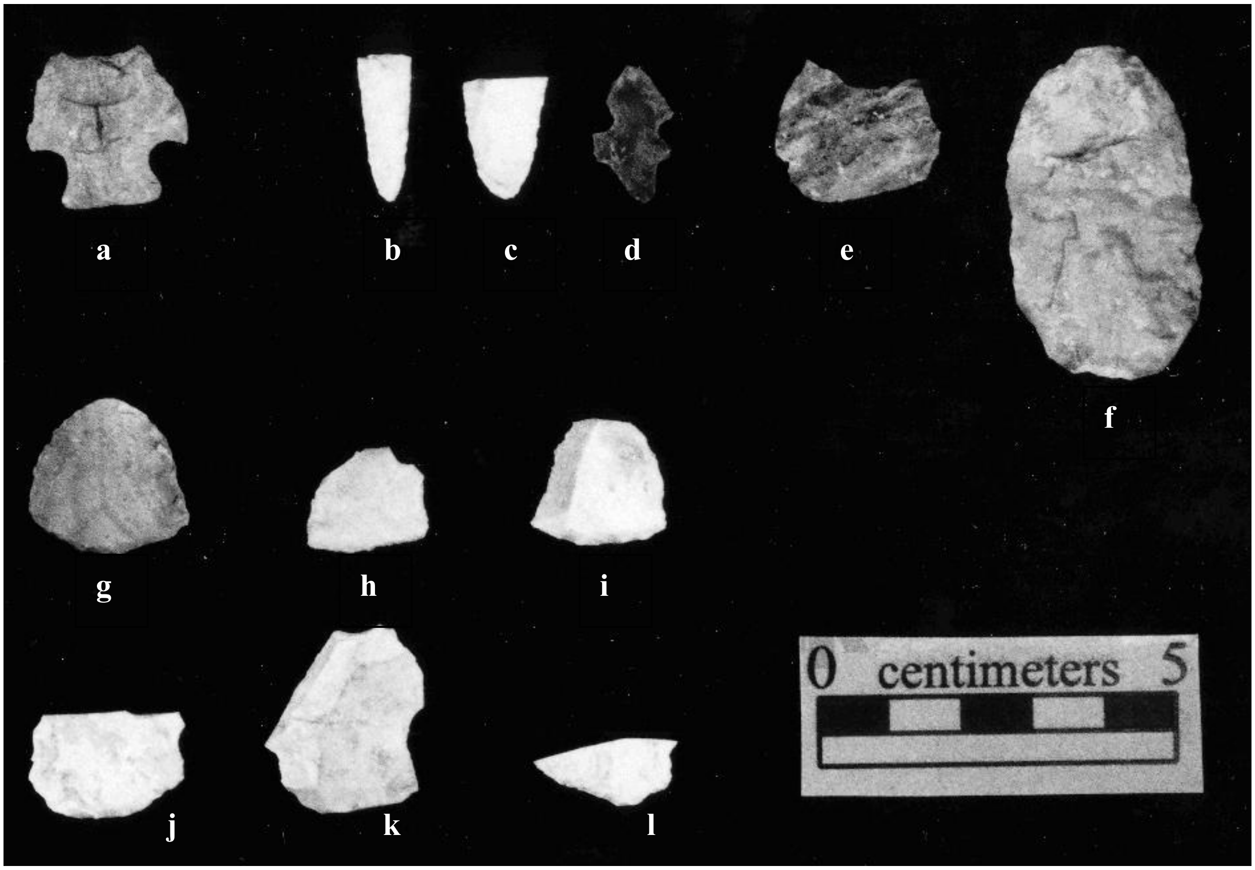


Figure 7.7. Duck Lake Lithics

Informal or expedient tools, consisting of retouched flakes and utilized flakes, comprise the majority of tools recovered from the site. Retouched flakes were defined as non-patterned expedient tools generally manufactured on a flake. One or more edges have been deliberately retouched to form a working edge. Flake scars from this retouch are small and do not exceed 1/4 of the width of the tool. Analysis of edge angles for working edges shows a median value of 67 degrees with a central range of 55 to 75 degrees (Ferone 1998:11). This was interpreted as indicating heavier wood working activities associated with these artifacts.

Utilized flakes differ morphologically from retouched flakes in that they exhibit use wear rather than deliberate retouch along one or more edges. No deliberate shaping, flaking, or retouch is evident, but use wear is indicated by dulled, shattered, or micro-flaked edges. Ferone (1998) has also demonstrated a difference in edge angle and possibly function between these tools and retouched flakes. Edge angles for utilized flakes are shallower than for retouched flakes, with a median value of 46.5 degrees and a central range of 30 to 65 degrees. The shallow median angle and wide central range is interpreted as indicative of the multi-function nature of utilized flakes, with light tasks such as skinning, hide scraping, and light woodworking being likely activities associated with these tools. A few utilized flakes exhibit steeper edge angles (72 to 90 degrees, n=10), and these were likely used for heavier processing tasks.

Debitage

Debitage was divided into two broad categories of cores, and flakes and shatter. Cores and core fragments are represented by seven pieces. At least three of these artifacts represent bipolar reduction based upon their polyhedral shape, small size, and crushing evident on both the upper and lower surfaces. While bipolar reduction is a common element of quartz technology in the region, all three bipolar cores from Duck Lake are chert.

Analysis of flakes and shatter followed a modified "*triple cortex*" typology (Andrefsky 1998:112-114; Morrow 1984). Proximal flakes were sorted into categories of primary, secondary, and tertiary flakes based upon the presence and extent of cortex on the dorsal flake surface. Additional categories included flake shatter and angular shatter, while "bifacial reduction" flakes was also identified. Primary flakes were defined by the presence of cortex or patina covering the entire dorsal surface of the flake, and are often thought to represent initial reduction stages in tool manufacture. Secondary flakes are defined by dorsal surfaces with both cortex and flake scars and these represent an early, but intermediate, reduction stage. Tertiary flakes lack dorsal cortex and often result from the later stages of reduction and tool maintenance. Flake shatter is defined as fragments of obvious flakes based upon presence of a single ventral surface, thinness, ripple marks, and terminations that are either feathered, stepped or hinged but that lack striking platforms or other surfaces of applied load. Controlled experiments have demonstrated that broken and incomplete flakes more often result from core reduction than tool production (Amick and Mauldin 1997:20; Andrefsky 1998:123-124). Angular shatter, consisting of blocky fragments of chert or quartz that lack striking platforms and other definitive flake elements, is a common byproduct of the early stages of reduction, especially with regard to quartz materials. Biface reduction flakes represent thinning, shaping, or maintenance activities associated with bifaces. They are typically a specialized type of tertiary flake, with a characteristic small, sharp lip that occurs at the junction of the striking platform and the bulb of percussion and which represents the remnant edge of a biface. Recent research into lithic fracture mechanics demonstrates that these flakes result from a non-hertzian fracture, and are now referred to as “bending flakes” (Andrefsky 1998:23-29, 2005:720-721). They often result from application of load from soft hammer or pressure techniques on the edge of a biface. Finally, all striking platforms were coded as cortical, flat, complex, abraded, crushed, or unidentifiable. These platform types have been correlated with type of reduction, with flat and cortical representing core reduction, and complex and abraded more commonly associated with reduction of bifaces (Andrefsky 1998:88-96).

Each of these categories represents a different aspect of tool production and use. To examine the potential differential use of local versus non-local lithics, debitage was examined by material type, typological category, and platform type. Significant differences were noted (Tables 7.7 and 7.8).

Table 7.7. Attributes of lithic debitage by material type (excluding cores)

Category	**PDC/Gal**	**On**	**KRF**	**Hix**	**Qtz**	**HBL**	**Bslt**	**Unid**	**Total**
Angular Shatter	71	0	0	0	42	4	0	11	128
Flake Shatter	340	0	0	2	19	9	1	17	388
Primary	6	0	0	0	0	1	0	1	8
Secondary	18	0	2	0	0	4	0	7	31
Tertiary	108	1	2	1	2	4		14	132
Biface Reduction.	18	1	2	0	0	0	0	1	22
TOTAL	**561**	**2**	**6**	**3**	**63**	**22**	**1**	**51**	**709**

Materials from the early stages of lithic reduction, especially angular and flake shatter dominate the quartz debitage assemblage (Table 7.8). It is worth noting that quartz assemblages are often skewed towards early reduction stage materials due to the poor flaking qualities of the material (Meinholz and Kuehn 1996). Nonetheless, given the nature of the quartz debitage and the local availability of this lithic material, it is likely that the early stages of quartz reduction occurred on site. Striking platforms found on quartz flakes are most frequently flat, further indicating reduction of cores as the primary activity associated with this material (Andrefsky 2007; Wilson and Andrefsky 2008).

Table 7.8. Frequencies of debitage attributes by material type (excluding cores).

Debitage Type	Quartz	HBL	PDC	Galena	KRF	Onondaga
Angular Shatter	66.13	14.29	10.22	47.06	0.00	0.00
Flake Shatter	30.65	42.86	62.28	29.41	0.00	0.00
Primary	0.00	4.76	1.18	0.00	0.00	0.00
Secondary	0.00	19.05	3.54	0.00	33.33	0.00
Tertiary	3.23	19.05	19.25	25.53	33.33	50.00
Biface Reduction	0.00	0.00	3.54	0.00	33.33	50.00

Table 7.9. Frequencies of proximal flake platform types by raw material.

Platform Type	Quartz	HBL	PDC	Galena	KRF	Onondaga	Hixton
Abraded	25.00	0.00	16.30	3.5	0.00	0.00	0.00
Complex	0.00	60.00	40.20	50.9	83.33	100.00	50.00
Cortical	0.00	20.00	2.20	3.5	0.00	0.00	0.00
Crushed	0.00	0.00	3.30	1.8	0.00	0.00	0.00
Flat	75.00	20.00	33.70	38.6	16.67	0.00	0.00
UnID	0.00	0.00	4.30	1.8	0.00	0.00	50.00

In addition to flake and angular shatter, the HBL chert debitage consists of cores, secondary flakes and tertiary flakes, with primary flakes relatively prominent. As with the quartz assemblage, this also appears to represent early stage reduction activities. Platform analysis (Table 7.9) also supports this conclusion with 40 percent of the flakes exhibiting either flat or cortical platforms. However, 60 percent of the HBL flakes exhibit complex platforms suggesting that later stages of reduction and perhaps biface production were taking place with this material.

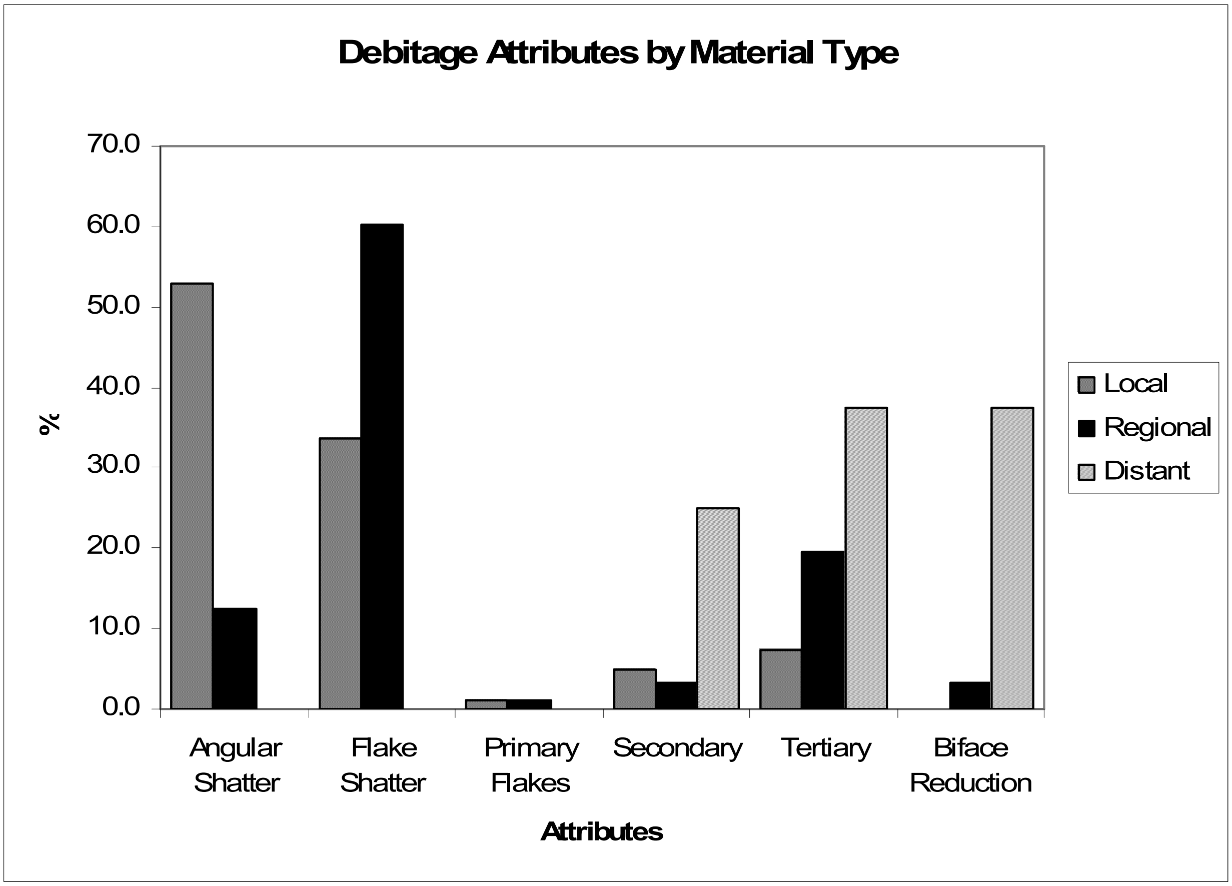


Figure 7.8. Frequency of debitage attributes by raw material type.

Regional non-local materials, including Prairie du Chien chert, Galena chert, and Hixton silicified sandstone, show a composition of debitage attributes that differs significantly from local materials, particularly in the higher frequencies of late stage reduction debitage (χ^2=84.46, df=4, p<.001). Whereas local lithics more frequently represent early stage reduction, regional lithics represent a wide range of activities from early stage reduction to tool production and maintenance (Figure 7.8). Early stage reduction is indicated by primary flakes, angular shatter and high frequencies of flake shatter, as well as by two cores. Tertiary flakes are common, and biface reduction flakes are also present. Over half of the platforms are complex or abraded, although over 30 percent are flat. Debitage size further highlights these differences by demonstrating local debitage (excluding shatter) has a mean weight of 0.9 grams while that of non-local regional lithics is only 0.5 grams.

Knife River flint and Onondaga chert debitage exclusively represent the later stages of artifact use life. This small assemblage is fairly divided between secondary, tertiary and biface reduction flakes with a complete lack of shatter and primary flakes. With the exception of one flat platform, all other striking platforms are complex. These materials were most likely brought to the site in the form of bifaces or other tools.

This lithic assemblage is consistent with a moderate amount of residential mobility within a defined territory. Materials such as Knife River Flint and Onondaga chert were likely obtained through exchange as tools, and their limited frequency and late reduction stage at Duck Lake is expected within a "down the line" model of exchange. Regional materials such as Prairie du Chien chert, Galena chert, and Hixton silicified sandstone were obtained either through trade or embedded procurement, and carried as both formal tools and raw material. The presence of cores and early stage reduction debitage shows that while formal tools were produced in anticipation of group mobility, moves were likely conducted over short distances and within a known region, thus facilitating the limited amount of logistical planning and preparation observed at this site. Also consistent with this view is the use of locally available materials such as quartz and Hudson's Bay Lowland chert for the production of expedient tools.

In summary, the regional and long distance lithic materials comprise a formal toolkit of "curated" tools and small cores, as would be expected with a degree of mobility. However, the utilization on non-local raw materials for cores and of local materials as expedient tools suggests a degree of familiarity with the locally available resources. Taken together, the picture that emerges from the lithic assemblage is one of residential mobility within a known region—

perhaps associated with seasonal aggregation and disaggregation of macro and microbands. Lithic procurement is characterized by two processes—embedded procurement of locally available materials and trade for exotic materials.

Copper Analysis

Eighty-seven copper items were recovered during investigations at the Duck Lake site (Table 7.10). Approximately half of these were recovered through formal excavation, the remainder were found through controlled metal detector survey. Most of the artifacts consist of worked, flattened, or otherwise modified but unshaped nuggets. Another 22.2 percent consist of unmodified nuggets of float copper imported to the site. The remaining 22.2 percent are tools, ornaments, preforms, or incompletely shaped artifacts.

Table 7.10. Copper Artifacts.

Description	**Count**	**Length (mm)**		**Width (mm)**		**Thick (mm)**		**Mass (g)**	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Small Globular Beads	2	6.9	3.7	7.2	3.3	2.9	0.1	0.1	0.0
Tubular Beads	1	18.8		11.0		6.1		4.4	
Bipoints	5	20.5	8.9	3.3	0.5	2.7	0.8	0.7	0.6
Tanged Knife	1	68.2		11.9		3.8		9.4	
Edged Tool Preform	1	44.7		15.5		3.9		11.5	
Triangular Preform	1	30.2		11.4		4.5		7.1	
Quadrilateral Preform	1	46.9		16.2		6.2		14.0	
Stemmed Point Preforms	2	50	14.8	12.3	1.6	4.3	0.2	8.9	1.8
Scrap	8							0.3	0.6
Shaped Copper	2	57	4.5	30.5	16.1	12.3	3.0	118.9	94
Worked Copper	42	21.1	7.2	13.2	5.7	5.5	2.5	5.1	6.6
Unworked Copper	21							2.2	1.9

This copper assemblage represents a wide range of copper artifact production. Many intermediate forms are present which represent preforms at various stages of completion. In addition, while the site is located only about 22 kilometers southeast of a primary source of copper in the Keweenaw Uplands, copper does not naturally occur within the well-sorted sediments of the sandy outwash plain on which the site is located. Therefore copper found on the site was imported, most likely from secondary sources in the moraine on the opposite side of the river or from gravel bars in the river valley itself.

Artifacts were divided into seven classes based on the presence and amount of modification of the native float copper, as well as on the morphology of finished or nearly finished tools. These categories include unworked copper nuggets, worked copper nuggets and waste, worked and shaped copper pieces, projectile point preforms, edged tools, bipointed objects, and beads.

Twenty one unworked copper nuggets were recovered during excavation and controlled metal detector surveys. Unworked copper nuggets tend to be small, averaging only 2.2 grams, and appear to represent glacially redeposited “float” copper.

Worked copper artifacts vary from hammered copper nuggets to small waste pieces. This is the largest category of copper artifacts, and the pieces tend to be small, ranging in weight from less than 0.1 grams to 35.7 grams. A few different classes of materials may be represented, including hammered nuggets and waste pieces, or scrap. Hammered nuggets represent worked pieces of float copper, while small waste pieces originate from hammering and removal of small projections from other worked pieces. Waste pieces are quite small, with a mean weight of 0.3 grams. Hammered nuggets are larger, with a mean weight of 5.1 grams, and may have been intended for later production of finished materials.

Copper pieces that have undergone greater modification and shaping yet do not clearly represent an identifiable tool type are designated as "worked and shaped." Two of these were found (Figure 7.9f, o). One is a sub-rectangular to lunate shaped item, with a rectangular cross-section. This is a relatively large artifact, with a weight of 52.4 grams. A second worked and shaped piece is the largest copper artifact recovered from the site with a weight of 185.4 grams. It is approximately rectangular with a rectangular cross-section.

Figure 7.9. Duck Lake copper artifacts.

Five artifacts are tentatively identified as representing intermediate stages in the production of projectile points. Two to three morphological classes are represented, including stemmed artifacts (Figure 7.9j, k), small triangular performs (Figure 7.9c, d), and a quadrilateral or diamond-shaped artifact (Figure 7.9b). These artifacts are often rectangular to lenticular in cross section, with blunt lateral margins. The stemmed form resembles the "ace of spades" points found at the Riverside site in Menominee County, Michigan (Hruska 1967), yet have not been fully drawn-out to their final width. The triangular preforms resemble specimens recovered on the Keweenaw Peninsula at 20KE20 where they were referred to as "wedges" (Martin 1993). At the Riverside site as well as at 20KE20, triangular points with the beginnings of sockets were found (Hruska 1967; Martin 1993) that might be intermediate between these triangular preforms and conical points or harpoons

Two edged tools, both apparently complete, were found during investigations at Duck Lake. The first of these is a small tanged "butter knife" form with a thin, slightly tapering rectangle shape and rounded tip (Figure 7.9e). The tang is approximately 18.6 mm in length and tapers to a blunt point. The second tool is a leaf-shaped blade with a lenticular cross-section (Figure 7.9a). One edge is sharpened, while the opposite edge appears to be blunted.

Five small bipointed objects or fragments were recovered. These artifacts are small, round to rectangular in cross-section, and terminate on each end in rounded to pointed tips (Figure 7.9l-n). The function of these artifacts is not readily apparent although they tend to co-occur with small beads and possible bead manufacturing debris. They appear too slender and gracile to have functioned as pressure flaking tools, but their use as awls cannot be ruled out. These artifacts are similar to those described as "pins" from 20KE20 (Martin 1993:148).

Two small round beads and one flattened tubular bead were recovered. The two small beads were found in the concentration of copper artifacts in Feature C (Figure 7.9g, h). These two beads are very similar, and both seem to have been manufactured by bending a small rectangular band of copper around a mandrel or possibly cordage, and then butting the ends together. The tubular bead has been flattened, and was found approximately 1.5 meters north of Feature A.

One unusual artifact consists of a long, narrow and very thin band of copper. When first found it was in one piece but was broken into five pieces during excavation due to its highly fragile condition. Combined, the five pieces measure a total length of 41.2 mm, and it has a rectangular cross-section that is 2.4 mm wide and 1.0 mm thick. This artifact is thought to perhaps represent a blank for the manufacture of small round beads.

Shovel testing, metal detector survey, and excavation revealed that copper was present in several concentrations on the site. Most was found to be concentrated in a roughly 10 meter wide by 120-meter long area along the low ridgetop in locality B (Figure 7.5). Copper materials were also found at the base of the ridge along the road and on the relatively level area between the ridge and the river valley to the northeast. Materials were not found on the moderate slopes of the ridge. Metal detector surveys were conducted to the south and west of the road with negative results, and around the road intersection in locality C with limited results.

Within the main distribution on the ridgetop, there were three smaller locations where copper materials appeared to be more densely clustered. No excavation was conducted around the first concentration, while a single unit in the second produced one piece of worked copper and one bipointed object. The block excavation exposed much of the third concentration.

Within the main block excavation, copper was concentrated around the three features as were most other cultural materials (Figure 7.6). Most of the copper was found within approximately 60 centimeters of Feature A. This area produced several pieces of worked and unworked copper, one triangular preform, two bipointed objects, and the possible bead blank. Fewer pieces were found around Feature B yet the association between copper, hearth, and an anvil stone was very clearly represented here. Worked and unworked copper pieces were present, and one piece of hammered copper was found directly over an anvil stone (Figures 7.6 and 7.10) next to the hearth. A third concentration, Feature C, was observed during excavations and was located almost halfway between the two hearths. This feature produced the two stemmed preforms, one bipointed object, and the two small beads.

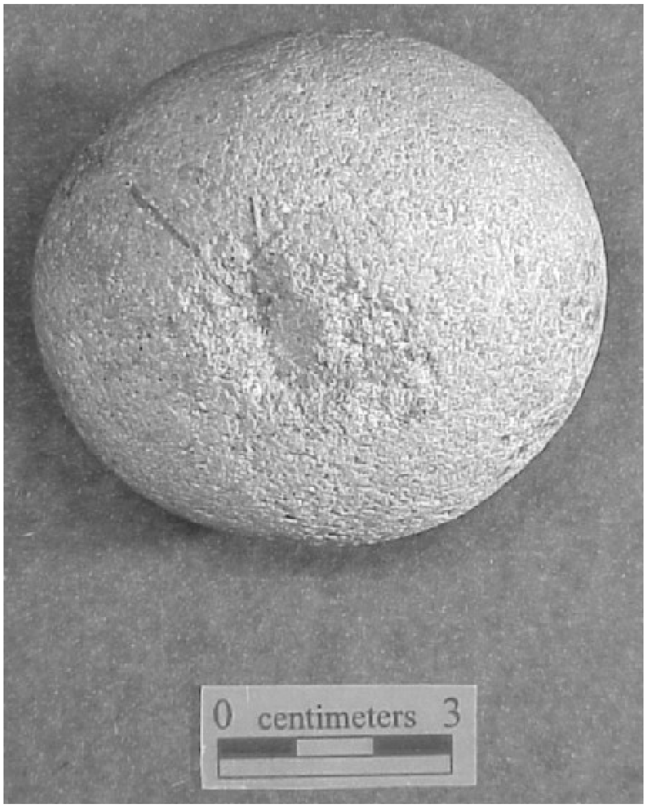


Figure 7.10. Anvil stone associated with Feature B and copper production debris

This area around these three features represents a small copper-working activity area where initial working of nuggets was done near the hearths as evidenced by the anvil stone and worked and unworked nuggets. This component is quite similar to that created by LaRonge (2001:380) during experimental recreations of copper production methods. Associated dates of 3420 ± 50 BP (Beta 099777) and 3400 ± 110 BP (Beta 124454) and a Preston-notched projectile point affiliate this workshop with the early Late Archaic.

Copper Production

A tentative copper production sequence can be proposed for the Duck Lake materials. While lithic reduction strategies have a long-standing analytical history, few have been developed for copper production technologies. The presence of an entire copper production sequence at the Duck Lake site makes it possible to propose an initial impression of copper tool and ornament production methods. Categories such as worked copper, preforms, and finished tools appear to represent a continuum of production with significant and notable objectives for each of these stages of production.

Copper artifacts were produced from small nuggets of glacially transported and deposited copper typical of till plains and glacial moraines. Based on the discarded unworked nuggets, these pieces of float copper tended to be relatively small. The average mass of unworked copper nuggets was found to be 1.7 ± 1.7 grams. However, selection factors may have led to discard of nuggets that were either too small or large, so this figure may be a biased representation of the nugget size selected for production of tools and ornaments.

Copper nuggets were initially hammered and annealed to remove projections and to begin rough shaping and flattening. Methods used to shape these pieces include hammering and annealing, grinding, cutting and twisting. The result of this step is a Stage I blank and small copper waste pieces or scrap. Stage I blanks include the category of worked and shaped copper discussed previously. The average mass of Stage I blanks is 10.2 grams; however, a wide variation in size suggests that these represent several different types of potential finished tools and ornaments.

The second stage of production is rough shaping and forming, leading to the production of preforms and blanks. At this point, Stage II artifacts are morphologically distinct, and clearly represent various tool/ornament types. Production of Stage II artifacts is done using hammerstones, anvil stones, and hammering and annealing methods. It is believed unlikely that much scrap is produced between Stage I and Stage II, although that conclusion is not readily apparent in the data.

Stage III is final shaping and sharpening of blade margins. The product is either a finished tool as seen in the edged tools (Figure 7.9a,e), or the preforms for socketed tools and beads. No significant waste material is expected from the production of Stage III tools, except perhaps copper dust from grinding and sharpening.

A fourth manufacture stage may be present with regard to socketed tools where the socket may be formed in Stage IV. Also, bead production may take place at this point after forming a long thin blank. In Stage IV, bead production would consist of folding the blank around a mandrel or piece of cordage, then hammering and grinding the overlapping edges. This stage is only tentatively identified based upon apparent trajectories of manufacture for conical points, and is not clearly represented in the Duck Lake data.

While artifacts deposited in the Duck Lake site appear to represent somewhat distinct stages of production, it is more likely they represent significant points on a continuum. Some sharpening or blade forming may take place in Stage II, some final removal of waste pieces may occur in Stage III. Yet overall, there seem to be a process involved with relatively sequential stages of production.

Discussion

Duck Lake provides an opportunity to examine Late Archaic mobility, resource procurement, and copper acquisition in the upper Great Lakes. Excavation revealed a small activity area around two hearths with domestic debris consisting of lithic tools, lithic debitage, and faunal remains. Copper is closely associated with the hearths, and a wide variety of copper forms are present. Unworked copper nuggets were transported to the site by human action, and the nearest source for copper is the glacial deposits associated with a ground moraine located immediately north of the site. Worked copper includes initially hammered forms, preforms for triangular and stemmed points, beads, and bipointed objects.

The chronology of the Late Archaic component is well established. Uncalibrated dates place the radiocarbon age of this component at approximately 3400 BP. Calibration of the two dates places the occupation at around 1685 to 1705 B.C. Duck Lake was in use just a short time after the Reigh site near Lake Winnebago to the south, and is contemporary with Burnt Rollways phase occupations at the Rainbow Dam East and West sites (Moffat and Speth 1999). Many earlier chronologies of the upper Great Lakes region would place this in the later portion of the Middle Archaic period, which is often dated up to around 3000 BP (e.g., Stoltman 1997:134; Martin 1999:162; Fitting 1975:68). More recent examination of Middle Archaic dates in the upper Midwest demonstrates the termination of that period by 2,000 B.C. (Kuehn 2002). Further, the presence of a small corner-notched projectile point similar to Monona Stemmed and Preston

Notched in direct association with the dated samples, copper production area and features associate Duck Lake with the early Late Archaic period.

The Archaic component at Duck Lake is largely consistent with the Burnt Rollways Phase first defined by Salzer (1974) in Oneida and Vilas counties of northern Wisconsin. Burnt Rollways was defined in the Highland Lakes region of northern Wisconsin, and additional investigations have extended it into the same physiographic region of adjacent Michigan (Hill 1994).

Seasonality of the occupation is tentatively suggested by seeds of bittersweet (*Celastrus scandens*) and maple (*Acer* sp.) recovered from feature fill. Bittersweet flowers in late May and June, and sets seeds in July to August. Sugar maple, the most likely maple species represented by the *Acer* sp. seed from Feature C, has seeds that mature in autumn. While the numbers of these seeds are small, their presence in Late Archaic cultural features suggests occupation during the late summer or autumn.

Duck Lake occupants participated in an extensive regional exchange system involving lithic materials. Non-local raw materials, including Prairie du Chien chert, Galena chert, Knife River flint, Onondaga chert, and Hixton Silicified Sandstone, dominate both the tool and debitage assemblages. Local lithics, including quartz and Hudson Bay Lowland chert, are most common among the expedient tools yet even here they remain a minority. Non-local lithics were brought to the site as both formal tools and cores as part of a “curated” lithic toolkit. Prairie du Chien and Galena cherts comprise most of the assemblage, and these materials have their nearest source approximately 200 miles down the Wisconsin River in the Driftless Region of Wisconsin and adjacent portions of Minnesota, Illinois, and Iowa (Klawiter 2001; Morrow 1994; Bury 1997). Prairie du Chien and Galena cherts are often found as minor components of other sites in the region during the Late Archaic (Moffat and Speth 2001, Pleger 2000), suggesting that their acquisition is somewhat commonplace at this time. Given the distances involved it is unlikely that direct acquisition of Prairie du Chien and Galena cherts was common. Instead, interactions between the northern highlands and the Mississippi Valley may have taken place in the form of regular contact and exchange between local populations.

It is unlikely that direct acquisition or embedded procurement accounts for the presence of more distant lithic materials such as Knife River flint and Onondaga chert. Onondaga chert has its source in the Lake Ontario region of New York state and Ontario, Canada (Hammer 1976; Wray 1948), approximately 500 miles from Duck Lake, while Knife River flint has its source in the Golden Valley Formation of western North Dakota some 700 miles to the west (Ahler 1986; Clayton et al. 1970). Acquisition of these materials is best explained through reliance on exchange networks. The debitage attributes of these materials suggest that they were brought to Duck Lake as tools which were used and maintained on site.

These regional and long distance lithic materials comprise a formal toolkit of “curated” tools and small cores, as would be expected with a population with a moderate to high degree of mobility. However, the utilization on non-local raw materials for cores and of local materials as expedient tools suggests a degree of familiarity with the locally available resources. The picture that emerges from the Duck Lake lithic assemblage is one of residential or logistical mobility within a known region.

Copper and Regional Exchange

Duck Lake provides an opportunity to gain a greater understanding of the acquisition of copper and its introduction into Archaic regional exchange systems. At the beginning of this chapter, several models of exchange were presented featuring different forms of interaction resulting in the movement of goods. The current archaeological consensus favors a down-the-line model of copper exchange in which copper is exchanged through frequent small-scale trade between neighboring groups resulting in a decline in copper frequency with distance. Does this model still fit the data with the addition of sites closer to the geological source?

The question is addressed by combining the data from the components discussed at the beginning of this chapter with the new data, unavailable to Fogel, from Duck Lake, 20KE20, and Burnt Rollways—all located within 100 kilometers of the Keweenaw copper sources.

Duck Lake on the southern end of the Keweenaw, and 20KE20 on the northern end of the Keweenaw Peninsula, are currently the two most thoroughly studied copper workshops in the southern Lake Superior basin. Unfortunately, 20KE20 was located and partially excavated by collectors prior to archaeological investigations by Michigan Technological University (Martin et al. 1993) Contextual information was largely lacking, but four radiocarbon dates established that the site was utilized from the Middle Archaic through to the Middle Woodland. Two of the dates, 3300 ± 60 BP and 3260 ±70 BP, indicate that at least one or two components are contemporary with Duck Lake.

Sites of the Burnt Rollways phase frequently contain evidence of the production of copper items including beads, crescents, points and awls (Salzer 1969, 1974). However, many of these sites contain multiple components, and the compressed stratigraphy characteristic of these northern sites creates difficulties in assigning individual artifacts to specific components. The Burnt Rollways site is an important exception, and can thus be included in this examination of copper distribution.

To limit bias from varying population densities throughout the region, data were not compiled from multiple sites within concentric rings from the source as was done by Fogel; instead, the number of copper items was compiled from each site which was then used as count of copper materials per component. Copper items included finished goods, preforms, waste copper and copper nuggets. The total number of non-debitage items was also compiled for each site, and the percentage of copper in this assemblage was then calculated. Debitage was excluded from this analysis so as to facilitate the comparison between mortuary and non-mortuary assemblages.

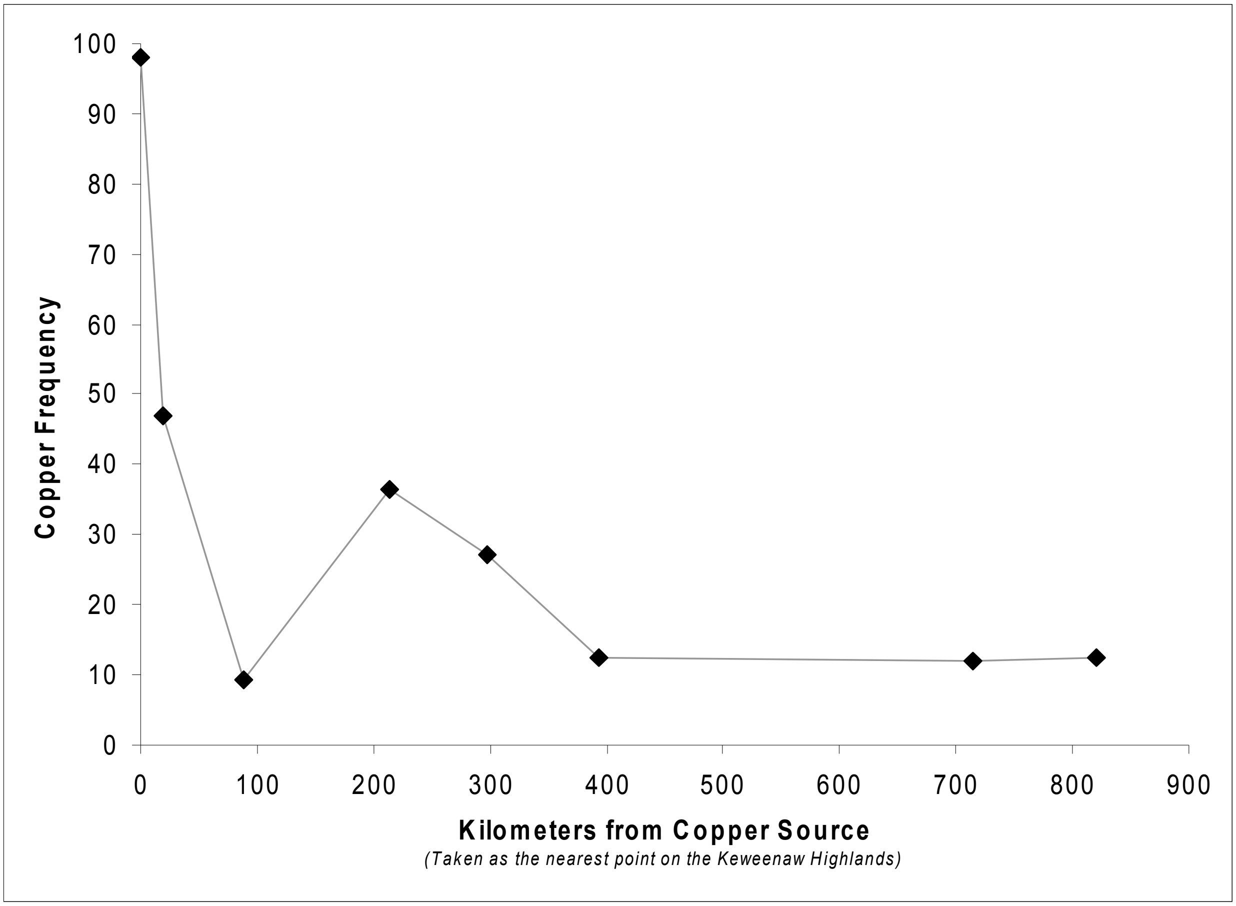


Figure 7.11. Copper frequency as a function of distance from the geological source on the south shore of Lake Superior. See Table 7.11 for the sites included.

Table 7.11. Copper by distance from source, including the percentage of the copper assemblage within categories of waste/nuggets/production debris, utilitarian items, and beads and other items of personal adornment.

Site	Distance (km)	Copper Count	% Copper excluding debitage	% Waste/ Nuggets	% Utilitarian	% Beads
20KE20	0	552	98.1	91.3	1.8	6.9
Duck Lake	19	87	47.0	83.0	12.5	4.5
Burnt Rollways	89	10	9.3	70.0	10.0	20.0
Riverside	214	688	36.4	1.3	12.4	86.3
Reigh	298	37	27.2	0.0	8.1	91.9
Price III	394	1	12.5	0.0	100.0	0.0
Doetsch	510	4	50.0	0.0	0.0	100.0
Morton F° 11	715	17	12.1	0.0	5.9	94.1
Klunk Mound 7	820	7	14.30	0.00	42.9	57.1

The resulting data (Table 7.11) and graph of copper frequency with distance from the source (Figure 7.11) provide a new perspective on the acquisition and exchange of copper during the latter part of the Archaic. Far from being absent, copper is quite plentiful on sites within 100 kilometers of the assumed source. At 20KE20, located on the geological source, copper comprises 98 percent of the total assemblage. The majority of the 552 copper items at this site are worked or unworked nuggets of native copper (Martin et al. 1993:148-151). Duck Lake also features a large percentage of copper and high frequencies of production debris. Moving farther away, sites of the Burnt Rollways phase often contain copper items; yet as the data from the Burnt Rollways site demonstrated, copper is a small percentage of the overall assemblage.

Farther still, copper is prominently featured in the mortuary and village assemblage at Riverside and the mortuary assemblage at Reigh. This produces an important peak on the copper distribution graph, and appears to validate Fogel's conclusion of the preferential acquisition and deposition of copper at these northern mortuary sites. From Riverside, the distribution of copper still resembles a down-the-line model in which copper frequencies decline with distance. However, the fact that copper frequencies level off at a distance of around 400 km, and copper is preferentially deposited in mortuary contexts, the distribution best fits an interpretation in which copper is valued, used, and distributed as a prestige item rather than as a commodity. The prestige chain model (Renfrew 1972:467-468) may therefore better fit the movement and exchange of copper during the later part of the Archaic.

The view that emerges is one of small residentially or logistically mobile groups in the northern highlands traveling northward during the warm season to the southern Lake Superior basin with copper acquisition as part of their goal. Within 100 kilometers of the source area, copper assemblages consist largely of waste or nuggets, tools and tool preforms, and small frequencies of beads or other adornments. Copper frequencies decline with distance from the source, partially consistent with a down-the-line model.

The trend changes by 200 kilometers from the source, corresponding with the Riverside site. Copper is more closely associated with mortuary contexts, and copper frequencies have dramatically increased as a result of preferential acquisition, use, and deposition at such significant sites as Riverside and Reigh. By way of illustration, there are more copper artifacts in Riverside Feature 17, the burial of a single infant, than in all the known Burnt Rollways phase sites combined. The nature of copper also changes at these sites, where copper assemblages are dominated by large numbers of beads and other items of personal adornment.

This change in the social function of copper is also evident when examining the frequencies of different types of items with distance. Figure 7.12 shows the proportion with distance trends for copper production debris, utilitarian items, and items of personal adornment. One outlier, Price III, has been excluded from this graph due to low sample size (n=1).

Production debris dominates copper assemblages within 100 kilometers of the source but is nearly absent by a distance of 200 kilometers. This distribution closely matches Renfrew's down-the-line model, and demonstrates that raw copper is exchanged through frequent small-scale interactions within the Northern Highlands. In this area, copper is exchanged between individuals who already share relations of kinship or tribal membership.

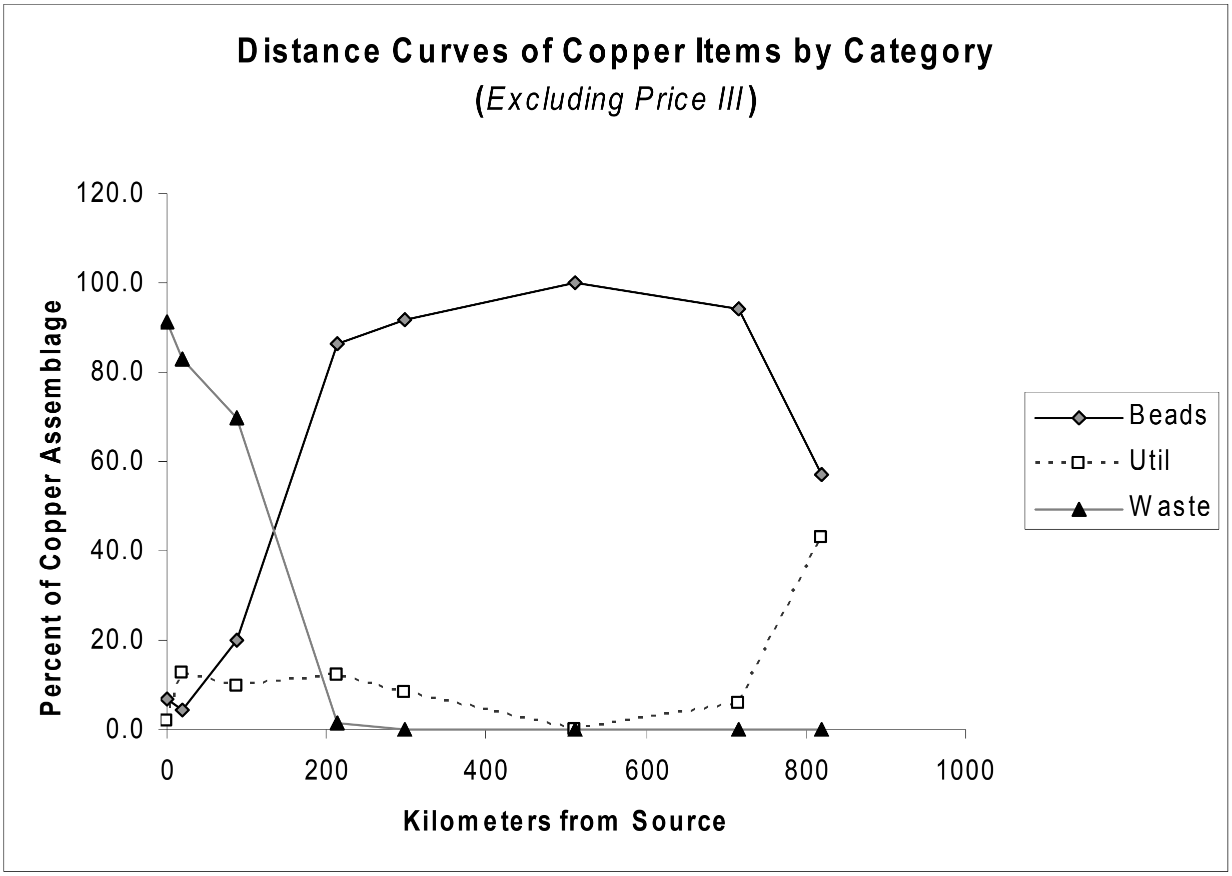


Figure 7.12. Copper frequency by distance for three classes of copper artifacts: 1) beads and objects of personal adornment, 2) utilitarian items, and 3) nuggets, waste, and production debris.

Utilitarian copper items occur at relatively constant frequencies throughout the region out to 800 kilometers, but beads and items of personal adornment increase dramatically with distance, as do other copper items around 800 kilometers, perhaps indicating that *all* copper functions as prestige items at this point. At a distance of 200 kilometers, the role and exchange of copper begins to more closely fit that of prestige goods as beads and other items of personal adornment become featured in the regional system. Exchange is no longer frequent and small-scale, but rather carries significant meaning across large social distances. Copper is used to convey symbolic meaning and is used to create and validate important social relationships.

Conclusion

Duck Lake, and other Archaic components close to the southern Lake Superior copper sources, offers a new perspective on copper, Archaic societies, and regional exchange. Copper may have been acquired by small mobile groups in the Northern Highlands, who produced copper goods for local use and possibly for exchange with neighbors and other groups to the south and southeast. The social nature of copper changes at a distance of 200 kilometers, when copper ornaments such as beads become prominent in the assemblages and copper is increasingly concentrated in mortuary contexts. The social, or prestige, value of copper is a dominant feature of the assemblage at sites such as Riverside and Reigh. Also at this point, copper is introduced into the regional exchange system not as commodity, but as a prestige good used to signal social identity, position, or relationships.

Copper exchange in the Midwest is not a uniform process. Its acquisition and use in the Northern Highlands is not unlike that of lithics or other functional resources, and its exchange most closely fits a down-the-line model. That changes as copper enters social systems in which relationships are created and maintained over large social and geographical distances. There, copper transforms from utilitarian to prestige. Its subsequent exchange through the midcontinent then fits a prestige-chain model, and it functioned in the creation and maintenance of important relationships over larger social distances.

CHAPTER EIGHT

TRACING EXCHANGE AND INTERACTION: USING LITHIC SOURCING AND CHEMICAL COMPOSITION OF COPPER TO IDENTIFY COMMUNITIES OF INTERACTION

Karl Polanyi (1957) defined trade and exchange as the movement of goods between hands—a definition that rightly emphasizes human action in the movement of material items. Sadly, though, it is only the material goods themselves that provide data for the archaeological study of trade and exchange (Renfrew 1972). We cannot watch the movement of materials between hands; we may only attempt to identify the material remains of such movement in a quest to reconstruct exchange networks and understand social processes involved in their past operation. Several methods make this possible, including examination of visual, mineralogical, or chemical characteristics of the materials to identify provenance (Bakewell 1996; Glascock 2002; Luedtke 1992; Pollard and Herron 1996; Shackley 1995, 1998, 2002; Tykot 2003); reconstructing *chaîne opératoire* of artifact procurement, production, use, exchange, and discard (Dobres 2000); and in the case of lithic materials, examination of lithic technological organization (Andrefsky 2009). This chapter will use visual sourcing of lithics and chemical trace element analysis of copper to first identify or characterize sources used by Burnt Rollways, Reigh, and Riverside communities and will then compare these communities with one another. I will ask if the materials in one site are consistent with the sources used in another. If the answer is yes, they *may* have been interacting communities; but if the answer is no, they were not.

The new data on regional copper distribution presented in Chapter Seven indicate that copper was acquired by Burnt Rollways populations in the Northern Highlands for the production of tools and ornaments and for local use and exchange, but at distances of 200 kilometers from the primary copper sources the use, exchange, and value of copper changes to fit a prestige-chain model. At Riverside, copper enters into a system of regional exchange and interaction that extends from northern Lake Michigan to the lower Ohio and middle Mississippi valleys.

Production of copper by Burnt Rollways communities is clearly occurring in the Northern Highlands, yet the changing nature of copper use and exchange at downstream contemporaries such as Riverside raises questions concerning the relationships between these two populations. In this chapter, the degree and nature of interaction between these populations will be explored by tracing the movement of copper and lithics from their geological source to their eventual deposition in archaeological components.

Two hypotheses may broadly characterize the types of interaction we might expect to see. In the first, communities of the Burnt Rollways phase are actively and formally interacting with contemporary communities in the Green Bay and Lake Winnebago areas. The location of Burnt Rollways sites near the primary sources of Keweenaw copper suggests that one possible source of the copper at Riverside—and through Riverside to other interacting communities to the south—lies with communities in the Northern Highlands. Burnt Rollways sites and their downstream contemporaries could even conceivably represent different seasonal aspects of the same communities practicing population dispersal and later aggregation at cemeteries such as Reigh and Riverside. They could also represent two separate and neighboring populations interacting through systems of exchange featuring the movement of copper from the Northern Highlands to the Green Bay and Lake Winnebago areas.

The second hypothesis proposes that Burnt Rollways represents a distinct and separate Northern Highlands population that is pursuing different economic strategies featuring little involvement with their neighbors to the southeast. Copper procured by Burnt Rollways communities is reserved for local use, while Riverside and Reigh must exploit other means and sources of obtaining copper for their social needs and interaction with others in the Midcontinent.

Methods

Lithic Sourcing

Lithic materials often exhibit characteristics that are unique to their geological formation process and setting. As shown in Chapter Three, several different lithic materials in the region and from more distant locations were used by Archaic populations in the western Great Lakes. The identification of these lithic materials and their geological sources is a multi-step problem (Luedtke 1992:109-113). The first step is to identify the region of interest and to characterize the types of materials expected to have been used. This will narrow the range of possibilities and limit the misidentification of similar lithic materials found in different regions. Review of geological and archaeological literature for the region the permits construction of an appropriate methodology to identify the likely materials.

Such a review was presented in Chapter Three in which a number of cherts, quartzites, orthoquartzites and other materials were defined and described. Visual characteristics such as color, texture, translucence, cortex, and inclusions such as fossils and oolites can be used to identify these lithic materials with a relatively high degree of accuracy. Several sources already describe these materials (e.g., Ahler 1986; Bakken 1997; Behm 1991; Boszhardt 1998; Clayton et al. 1970; Gonsior 1996; Hammer 1976; Hill 1994; Klawiter 2001; Luedtke 1992; Morrow 1994; Morrow and Behm 1988; Van Dyke 1985; Winkler and Blodgett n.d.; Wray 1948); the reader is referred to these for further detail on the qualities of western Great Lakes and exotic lithics.

Descriptions are useful, but often fail to sufficiently characterize the range of variability and qualities of the material, and similar characteristics can occasionally be found in different materials. For example, small pieces of non-oolitic white-to-light gray Prairie du Chien chert can be confused with Burlington chert without careful examination. To minimize the potential of this problem, chert sources were visited during the summers of 2005, 2006, and 2007 to examine their geological context and to collect comparative samples. These were added to an already extensive collection of North American lithics, and this collection was further enhanced by obtaining samples of lithics from professional contacts in Minnesota, Indiana, Wisconsin, and Michigan. The result is a large comparative collection of Midwest lithic source samples that supplement the available descriptive literature and characterize the range of variability and qualities of 20 different lithic materials from 27 source locations (Figure 8.1).

These comparative and descriptive materials were used to identify the raw materials represented in the debitage and lithic tools from Archaic components in the western Great Lakes. Unfortunately, not all of the components were equally suited to this analysis due to small sample sizes or difficulty in separating Late Archaic components from later occupations. Assemblages from sites such as Kapitz were too small to accurately characterize the lithics. The Rainbow Dam sites would seem to be ideal candidates for this analysis, but their utility was limited due to the original low resolution identification of lithics into broad categories such as “chert” (Moffat and Speth 1999), combined with an inability to accurately assign lithics in the collection to either the Archaic or the Woodland components. As a result, collections from the Duck Lake (n=805)

Figure 8.1. Sample locations of twenty different lithic materials that comprise the lithic comparative collection used in this study.

and Burnt Rollways (n=3627) were used to characterize the lithic assemblages of the Burnt Rollways phase.

A different problem was confronted at Reigh and Riverside. Excavation at Reigh focused largely on burial features. As a result, lithics from any occupational components are poorly and unsystematically represented, leaving just the deliberately interred grave goods to represent the lithic materials in use by this population. The limited number of grave goods further reduces this sample, so that only 14 lithic artifacts are present.

Riverside poses a similar problem in that most excavation was focused on the burial features. So called "village" materials were found in quantity, but their association with any Archaic or later components is poorly documented. As a result, only those lithics found in burial features were included. These represent two different types of deposition; artifacts deliberately interred with the dead and those inadvertently included in feature fill. For the latter category, these materials were available at the time these features were filled and thus cannot date later than the Red Ocher component. As such, they are perhaps the best available indicator of lithic materials used by the population during this period.

Another problem is found with the Riverside materials. Collections from this site were split between different repositories. The majority are housed at the Milwaukee Public Museum, where they are available for research. A smaller quantity was curated at the Oshkosh Public Museum. Subsequent NAGPRA decisions at the Oshkosh Public Museum led to the 2001 repatriation and reburial of these collections (Joan Lloyd, personal communication, August 2007). As a result, only collections from seventeen features curated in their entirety at the Milwaukee Public Museum were available for analysis. These included Features 3, 13, 14, 17, 18, 21, 25, 27, 28, 29, 31, 32, 35, 41, 43, and 45, with a total sample of 193 lithic artifacts.

Each artifact was examined visually and under 10X to 40X magnification using a binocular microscope. Reflected and transmitted light was used to closely examine artifacts that were difficult to attribute to specific sources. In cases where artifacts resembled two or more different types of raw material, comparative samples of those materials were examined microscopically side by side with the artifact to look at texture, translucence, and inclusions that could differentiate one material from the other. In cases where the identification was in doubt, samples were coded as unidentified. Examination of these collections identified twenty different lithic raw materials (orthoquartzites were lumped into one category due to difficulty in visually identifying specific sources and the proximity of known sources to one another) ranging from regional materials such as Prairie du Chien chert to more exotic sources including Knife River Flint, Onondaga chert, and Wyandotte chert.

Copper Compositional Analysis and Sourcing

Unlike lithics, copper cannot be sourced by visual characteristics, and detailed studies of technological organization lie in the future after copper technology is better understood. Several studies by geoarchaeologists and others (e.g., Levine 1996, 2007; Pletka 1991; Rapp 1990; Rapp et al. 1980, 2000) have demonstrated that trace element composition varies with respect to the geological source of copper and can be used to identify source areas utilized by prehistoric populations.

All compositional methods rely on what Glascock (2002) refers to as the *Provenance Postulate,* which states that in order for chemical characterization to be successful in identifying a likely source, there must be greater heterogeneity between sources than within sources. Tykot (2003) states that successful provenance studies first require that all potential sources in the region of interest be known and chemically characterized before analyzing archaeologically derived materials. George Rapp at the University of Minnesota has spent the past three decades collecting and analyzing copper samples throughout North America, especially in the Lake Superior region (Rapp 1990; Rapp et al. 1980, 2000).

In this study, Laser Ablation-Inductively Coupled Plasma Mass Spectrometry (LA-ICPMS) was selected to characterize the chemical composition of copper artifacts and source samples. LA-ICPMS uses a laser to vaporize a tiny sample of copper, approximately the same size as the period at the end of this sentence. The resulting gas is then analyzed by a mass spectrometer to assess the sample's trace element composition (e.g., Pollard and Heron 1996; Speakman et al. 2002). LA-ICPMS is a highly sensitive technique for identifying elemental and isotopic composition of materials, and its small sample size provides a significant advantage for the analysis of museum specimens and other copper artifacts in which any adverse effects must be eliminated or kept to a minimum.

Samples were selected from the Archaic components at Duck Lake, Burnt Rollways, Rainbow Dam East, Rainbow Dam West, Reigh, Riverside, and Thiensville sites by first selecting a subset that was small enough to fit in the ablation chamber (< 5 cm). Following that the sample was stratified—by artifact type at the Burnt Rollways phase sites, and by feature association at Riverside and Reigh. A 20 percent sample was then randomly generated from each of these strata. Due to concerns raised by the lending institutions, this was further reduced for the Riverside sample. As a result, the final sample consisted of 91 copper artifacts from these seven sites, as shown in Table 8.1.

These copper samples were supplemented by 61 copper source specimens (Table 8.1) from sources on the Keweenaw Peninsula, eastern Minnesota, Isle Royale, Michipicoten Island, North Carolina, Pennsylvania, Nova Scotia, and Newfoundland (Figure 8.2). These samples had been collected for copper source analysis by George Rapp of the University of Minnesota, subsequently curated at Michigan Technological University, and then made available for this analysis.

Table 8.1. Summary of artifact and geological source sample copper used for compositional analysis.

Site/Source	**State/Province**	**Artifact/ Geological**	**Cultural/Geographical Association**	**N**
Burnt Rollways	Wisconsin	Artifact	Burnt Rollways Phase	8
Duck Lake	Michigan	Artifact	Burnt Rollways Phase	19
Rainbow Dam East	Wisconsin	Artifact	Burnt Rollways Phase	1
Rainbow Dam West	Wisconsin	Artifact	Burnt Rollways Phase	10
Reigh	Wisconsin	Artifact	Reigh Phase	14
Riverside	Wisconsin	Artifact	Red Ocher	36
Theinsville	Wisconsin	Artifact	Red Ocher	3
			Artifact Total	91
Cap d'Or	Nova Scotia	Geological	Maritimes	3
Trout River	Newfoundland	Geological	Maritimes	4
Centennial Mine	Michigan	Geological	Keweenaw, Lake Superior	6
Champion Mine	Michigan	Geological	Keweenaw, Lake Superior	10
Minesota Mine	Michigan	Geological	Keweenaw, Lake Superior	5
Michipicoten Island	Ontario	Geological	Michipicoten Island, Lake Superior	6
Minong Mine	Michigan	Geological	Isle Royale, Lake Superior	8
Snake River	Minnesota	Geological	Snake River, Lake Superior	10
Cornwall	Pennsylvania	Geological	Appalachians	1
Greenstone	Pennsylvania	Geological	Appalachians	2
Adams County	Pennsylvania	Geological	Appalachians	5
Gold Hill	North Carolina	Geological	Appalachians	1
			Source Total	61

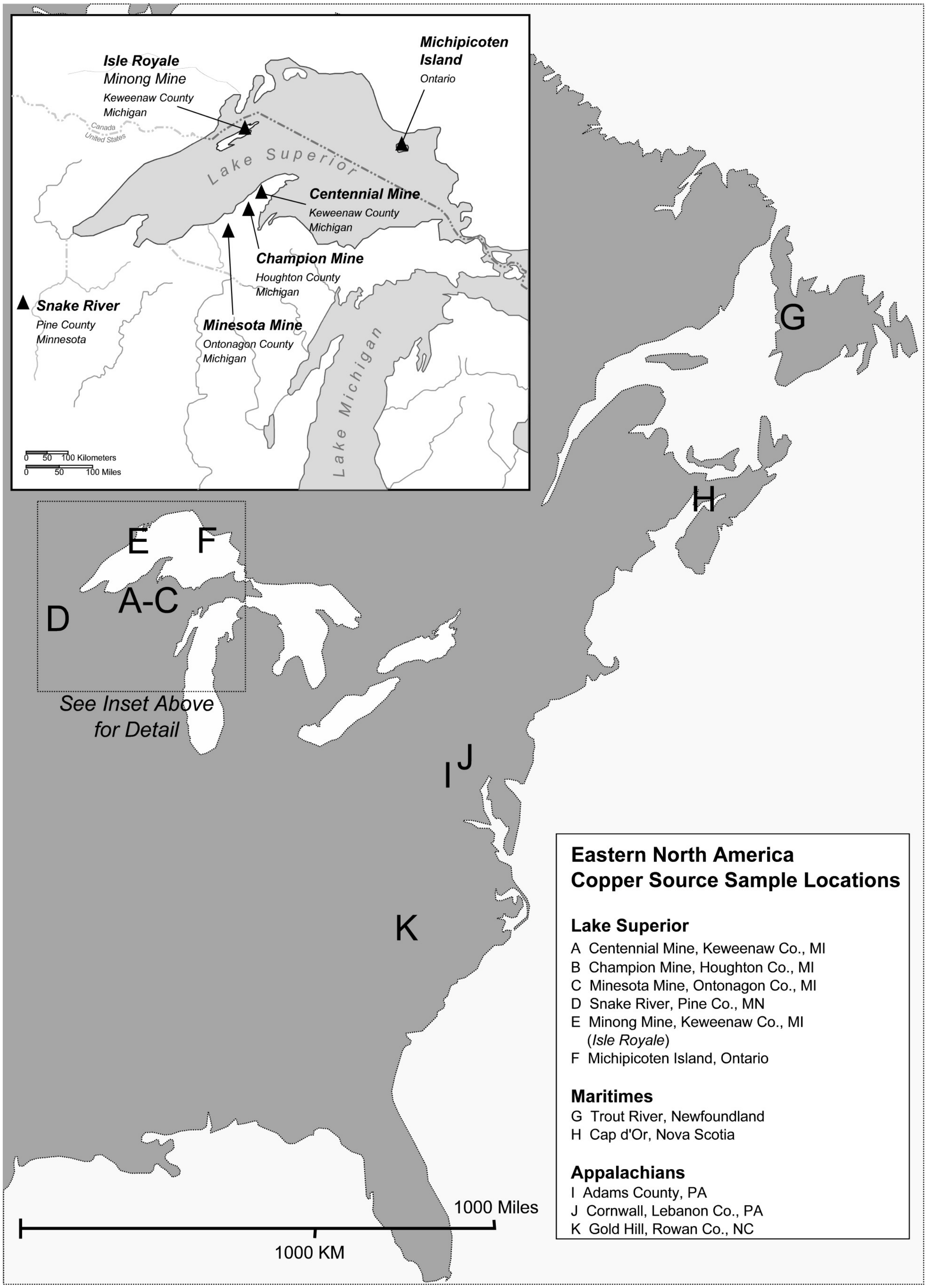


Figure 8.2. Location of geological copper samples used in LA-ICPMS trace element analysis.

The artifact and source samples were taken to California State University – Long Beach for analysis at the Institute for Integrated Research in Materials, Environment, and Society (IIRMES). LA-ICPMS was then performed on the samples using a New Wave Research UP-213 Laser Ablation system coupled with a GBC OptiMass 8000 ICP time of flight mass spectrometer. Three standards were used for data calibration, including SRM 1107 Naval Brass, SRM 500 Unalloyed Copper, and SRM 1110 Red Brass. Laser ablation of samples was accomplished using 300 to 550 mJoules with at least one ablation pass to clean the sample prior to starting the spectrometry. Ablation passes to remove potential contaminants and oxidation were conducted with the laser set with a 100 µm beam, while the laser was reduced to a 50 µm beam for the spectrometry passes to further limit the potential for contamination. Many of the artifact samples exhibited oxidation of varying thickness, and a video magnification system allowed for real-time observation of the ablation process, providing a clear view of the point at which the oxidized layers were ablated from the sample and clean copper was visible. Spectrometry was only attempted after it appeared that the oxidized layers had been largely or completely removed.

While one of the strengths of LA-ICPMS is that it allows for microscopic sampling of artifacts, and thus can be applied to museum specimens with little adverse effect on the appearance of the artifact, this also poses a potential analytical problem. Copper artifacts are not internally homogenous and elemental composition can vary from one location to another on a sample. Unlike bulk techniques that test the composition of entire artifact, such as instrumental neutron activation analysis, LA-ICPMS samples the composition of discrete locations. To account for this variability, two samples were collected from each artifact to more accurately characterize both the composition and variability of elements within the sample.

Spectrometry recorded concentrations of thirty seven elements (Appendix VII). These data were then transformed in three steps: first, sodium (Na) rubidium (Rb) and bromine (Br) were removed from the data since research has shown that they are not geochemically relevant for copper (Rapp et al. 2000:53). Next, all elements that were not present in at least one third of the source sample were removed. As a result, gold (Au), platinum (Pt), and tantalum (Ta) were removed from further analysis. In the final step, the remaining data on 30 elements were transformed to enhance normality using a power transformation. Often, elemental data requires transformation to enhance normal distribution due to great variation in the amounts of different elements in the material. In many analyses, the data is logged to enhance normality yet previous analysis of copper data suggests that power transformations are more effective (Rapp et al. 2000). As a result, the power transformation shown in Formula 8.1 was used to normalize the trace element data.

Formula 8.1. $X^{(\lambda)} = X^{1/5} - 1/(1/5)$

Analyses of these data proceeded in several steps. First, the data from only artifactual copper was analyzed to examine relationships between the copper assemblages of each site without *a priori* assumptions about the geological provenance of the copper. Afterward, the artifactual and source samples were analyzed together in an attempt to determine the most likely geological sources of copper for each Archaic component.

Statistical analysis was performed using SPSS Version 10. The element copper was not used in any of the analyses since its average of 97 percent masked relationships between trace elements in the samples. The remaining thirty elements were then first subjected to principal components analysis to identify meaningful covariation between elements and to identify a set of composite variables, or Components, for further analysis. Component scores were saved for each sample, and were then subjected to Discriminant Function Analysis to examine relationships between samples and components, and later the relationship between samples, components, and likely geological sources.

Results

Lithics

A comparison of lithic tools from Duck Lake, Burnt Rollways, Reigh, and Riverside provides a quick measure of the nature of lithic resource utilization at each of these sites. Due to the differing nature of the site formation processes and excavation methods at these four sites, tools provide the most comparable data. Tools were visually examined and compared with written descriptions and comparative collections to identify their raw material and geologic provenance (Table 8.2).

As shown in the previous chapter, lithic tools from the Duck Lake site suggest some degree of interaction with groups to the southwest since the majority of the tools and debitage were manufactured from Prairie du Chien and Galena cherts. The majority of Duck Lake tools are manufactured from Prairie du Chien and Galena cherts from lithic resource zone III (see Chapter Three and Figure 3.6 for lithic resource zones). The majority of lithic tools from the Burnt Rollways site are also manufactured from Zone III cherts including Prairie du Chien and Galena. Unlike Duck Lake, however, a wider variety of lithic materials are present, including orthoquartzites from Zone III, Jasper Taconite and Knife Lake Siltstone from the north shore of Lake Superior, and Silurian chert from Zone V. Knife River Flint is absent, but Onondaga chert from the eastern Great Lakes is present. While many of the tools exhibit wear and maintenance, many tools appear to have less wear than Duck Lake materials. The greater variety of lithic materials reflects, in part, the larger sample size at Burnt Rollways and probably a more diverse and longer occupation.

Table 8.2: Lithic tool raw materials by component (excluding quartz).

Lithic Material	Reigh Phase		Burnt Rollways Phase				Riverside					
	Reigh		Duck Lake		Burnt Rollways		Riverside		Riverside w/o Wyandotte Bifaces		Total w/o Wyandotte Bifaces	
	#	%	#	%	#	%	#	%	#	%	#	%
Wyandotte	0	0	0	0	0	0	116	88.55	3	17.65	3	1.67
PDC	3	23.08	52	57.14	26	44.07	4	3.05	4	23.53	85	47.22
Galena	8	61.54	11	12.09	1	1.69	5	3.82	5	29.41	25	13.89
Unid	0	0	15	16.48	9	15.25	2	1.53	2	11.76	26	14.44
HBL	0	0	8	8.79	2	3.39	0	0	0	0	10	5.56
Silurian	1	7.69	0	0	4	6.78	2	1.53	2	11.76	7	3.89
Argillite	0	0	0	0	6	10.17	0	0	0	0	6	3.33
KRF	0	0	4	4.4	0	0	0	0	0	0	4	2.22
Orthoquartzite	0	0	0	0	4	6.78	0	0	0	0	4	2.22
Quartzite	0	0	0	0	1	1.69	1	0.76	1	5.88	2	1.11
Burlington	0	0	0	0	1	1.69	1	0.76	0	0	1	0.56
Onondaga	0	0	1	1.1	1	1.69	0	0	0	0	2	1.11
Basalt	0	0	0	0	1	1.69	0	0	0	0	1	0.56
Rhyolite	1	7.69	0	0	0	0	0	0	0	0	1	0.56
Knife Lake	0	0	0	0	1	1.69	0	0	0	0	1	0.56
Cochrane	0	0	0	0	1	1.69	0	0	0	0	1	0.56
Pipestone	0	0	0	0	1	1.69	0	0	0	0	1	0.56
Jasper Tac	0	0	0	0	0	0	0	0	0	0	0	0
Total	13	100.0	91	100.0	59	100.0	131	100.0	17	100.0	180	100.0

These two sites reveal a lithic raw material profile of the Burnt Rollways phase tools that emphasizes the use of Prairie du Chien chert over Galena chert. In contrast, this emphasis shifts to favor Galena chert at both the Reigh and Riverside sites. Hafted bifaces, both projectile points and large specialized bifaces, dominate the tool assemblage from Reigh. These lithics are notable for the exclusion of non-local materials and the dominance of Galena chert; the large hafted bifaces are manufactured largely from Galena, while projectile points are manufactured from Galena, Prairie du Chien, Rhyolite, and Silurian chert—all available within 100 kilometers. The lithic tools from Riverside are dominated by specialized bifaces of Wyandotte chert which mask the remainder of the lithic tool variation. Removing the Wyandotte bifaces reveals that the remainder of the assemblage consists of Galena, Prairie du Chien, and Silurian cherts with Galena chert being the most common. Excluding the Wyandotte bifaces, the lithic profiles of Riverside and Reigh are observed to be highly similar ($t=0.00$, $df=11$, $p<1.0$).

Differences between lithic tools at Reigh and Riverside on one hand and Burnt Rollways phase sites on the other, are notable, particular in the latter's emphasis on the use of Prairie du Chien chert more than Galena, the use of HBL from the Northern Highlands, and the presence of Onondaga chert from the eastern Great Lakes. While differences between Burnt Rollways and Reigh, and Burnt Rollways and Riverside are notable, they cannot be demonstrated to be statistically significant using tool data alone ($t=1.555$, $df=11$, $p=.148$ and $t=1.579$, $df=11$, $p=.143$ respectively).

To determine if Burnt Rollways, Reigh, and Riverside are using the same lithic resources—or perhaps interacting through the exchange of lithic resources—the analysis must expand beyond tools to include the entire available lithic assemblages. Raw material types for tools and debitage were then compiled, as shown in Table 8.3, expanding the sample size to 1940 artifacts. Most of these are from the two Burnt Rollways components, although the Riverside sample without Wyandotte bifaces expands to 98.

Table 8.3. Lithic tools and debitage by lithic raw material.

	Reigh Phase		Burnt Rollways Phase				Riverside					
Lithic Material	**Reigh**		**Duck Lake**		**Burnt Rollways**		**Riverside w Wyandotte Bifaces**		**Riverside w/o Wyandotte Bifaces**		**Total w/o Wyandotte Bifaces**	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Wyandotte	0	0	0	0	0	0	116	54.72	3	3.06	3	0.15
PDC	3	21.43	579	78.03	304	27.99	15	7.08	15	15.31	901	46.44
Galena	9	64.29	45	6.06	22	2.03	22	10.38	22	22.45	98	5.05
Unid	0	0	66	8.89	269	24.77	23	10.85	23	23.47	358	18.45
HBL	0	0	30	4.04	44	4.05	0	0	0	0	74	3.81
Silurian	1	7.14	0	0	105	9.67	28	13.21	28	28.57	134	6.91
Argillite	0	0	0	0	10	0.92	0	0	0	0	10	0.52
KRF	0	0	10	1.35	7	0.64	0	0	0	0	17	0.88
Orthoq.	0	0	3	0.4	225	20.72	0	0	0	0	228	11.75
Quartzite	0	0	5	0.67	32	2.95	4	1.89	4	4.08	41	2.11
Burlington	0	0	0	0	7	0.64	1	0.47	0	0	7	0.36
Onondaga	0	0	3	0.4	1	0.09	0	0	0	0	4	0.21
Basalt	0	0	1	0.13	21	1.93	3	1.42	3	3.06	25	1.29
Rhyolite	1	7.14	0	0	16	1.47	0	0	0	0	17	0.88
Knife Lake	0	0	0	0	5	0.46	0	0	0	0	5	0.26
Cochrane	0	0	0	0	5	0.46	0	0	0	0	5	0.26
Pipestone Jasper	0	0	0	0	1	0.09	0	0	0	0	1	0.05
Taconite	0	0	0	0	4	0.37	0	0	0	0	4	0.21
Felsite	0	0	0	0	8	0.74	0	0	0	0	8	0.41
Total	14	100	742	100	1086	98.34	212	100	98	100	1940	100

As an initial exploration, these data were used in a Ward's method hierarchical cluster analysis to compare the lithic resource patterns from each site. Hierarchical cluster analysis is an agglomerative technique; it starts by comparing each case and builds clusters based on a measure of distance between each case until all are ultimately combined into one group (Shennan 1997:235-236). This method allows us to examine which sites are more closely associated in terms of their patterns of lithic resource utilization.

Analyses were performed with and without the Wyandotte bifaces at Riverside with the same results. Two clusters were produced, with Burnt Rollways and Duck Lake in one, and Reigh, Riverside-with, and Riverside-without Wyandotte bifaces tightly grouped in the other

(Figure 8.3). This matches the result obtained through an examination of lithic tools, and suggests that the Burnt Rollways phase sites are utilizing one set of lithic resources while those used by Reigh and Riverside differ somewhat. Discriminant function analysis, which assumes that these clusters are real and attempts to use the original data to reassign cases to clusters (Shennan 1997:220), was successful in matching 100 percent of the cases to these groups.

So the Burnt Rollways phase communities are using one set of resources, while Reigh and Riverside are using a different set. The differences between these two sets can be explored using principal components analysis, an ordination method which identifies how the different lithic materials may covary and interact in multi-dimensional space, and thus reduces the total number of variables to a smaller number of composite variables or *components* (Shennan 1997:269-281). Component scores are calculated that then represent the relationship between these components and the original variables. In this case, the analysis identifies sets of lithic resources that are responsible for the majority of the differences between components.

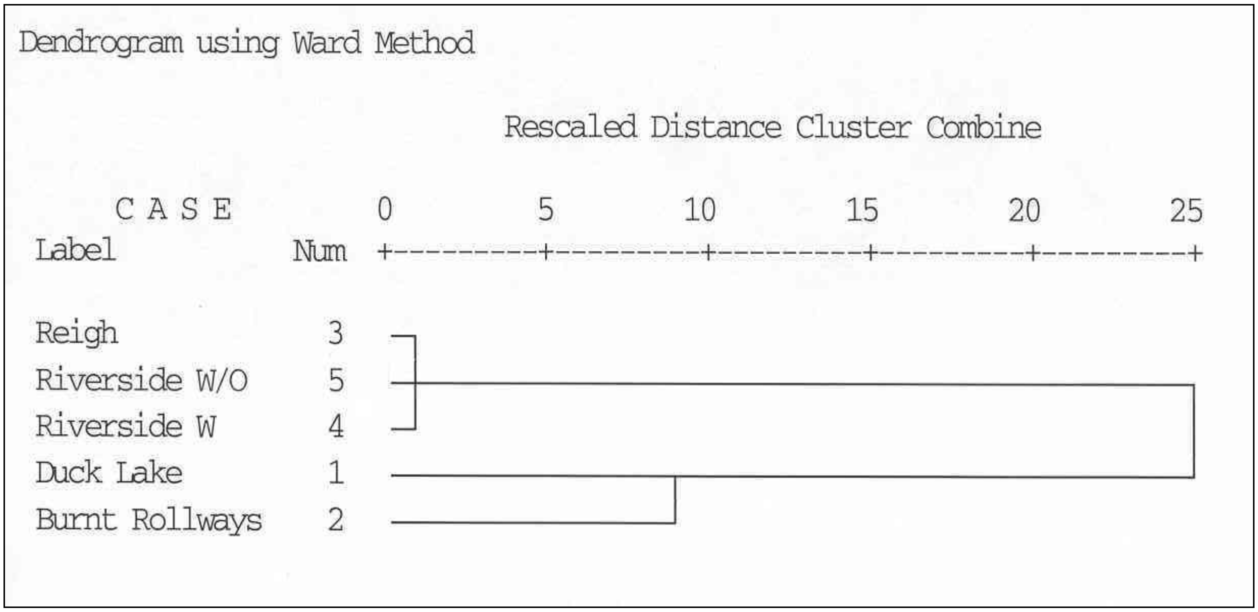


Figure 8.3. Dendrogram of lithic raw material cluster analysis.

An analysis was conducted in which the first three components accounted for 99.2 percent of the variance. This analyses identified Prairie du Chien, Galena, Knife River Flint, and Onondaga as loading strongly on component two, while most of the remaining lithics loaded strongly on component one (Table 8.4). Component three accounts for only 4.9 percent of the variability in the data, yet is most strongly associated with Wyandotte chert and therefore confirms earlier observations of important variability that further distinguishes Riverside from the other three components.

Table 8.4. Factor scores from a principal components analysis of lithic raw materials sources.

	Component		
Lithic Material	**1**	**2**	**3**
Wyandotte	-0.287	-0.336	0.889
Prairie du Chien	0.382	0.921	0.035
Galena	0.041	0.923	0.295
Unidentified	0.996	0.077	0.041
HBL	0.853	0.518	0.002
Silurian	0.924	-0.300	0.144
Argillite	0.992	-0.125	-0.021
Knife River Flint	0.530	0.844	0.017
Orthoquartzite	0.993	-0.112	-0.020
Quartzite	0.995	-0.043	0.064
Burlington	0.977	-0.176	0.110
Onondaga	0.208	0.975	0.027
Basalt	0.979	-0.168	0.070
Rhyolite	0.985	-0.147	-0.059
Knife Lake Siltstone	0.992	-0.125	-0.021
Cochrane	0.992	-0.125	-0.021
Baron Co. Pipestone	0.992	-0.125	-0.021
Jasper Taconite	0.992	-0.125	-0.021
Felsite	0.992	-0.125	-0.021
Eigenvalue	*13.890*	*4.030*	*0.930*
% of Variance	*73.103*	*21.214*	*4.893*

This analysis identifies differences in the utilization of Prairie du Chien, Galena, Onondaga, and Wyandotte cherts and Knife River Flint as distinguishing characteristics that separate the sites of the Burnt Rollways phase from Reigh and Riverside. Using only these lithic resources, a second series of cluster analyses using several different methods (including Ward's method, nearest neighbor, farthest-neighbor, averaging linking, and non-hierarchical k-means) produced the same results as earlier—Duck Lake and Burnt Rollways cluster together, but separate from a second cluster that includes Reigh and Riverside. The robustness of this result illustrates that sites in the Northern Highlands are utilizing more Prairie du Chien than Galena cherts, and participate in interaction with other distant groups to the east and west that provide access to limited quantities of Knife River Flint and Onondaga chert. In contrast, Reigh and Riverside utilize many of the same lithic resources, but feature the use of Galena chert over Prairie du Chien and, in the case of Riverside, exhibit significant interaction with communities to the south that provide access to formalized bifaces of Wyandotte chert.

Burnt Rollways and Reigh-Riverside are using different, but overlapping, lithic resource areas. This differential use of lithics supports the hypothesis that these represent different populations—one in the Northern Highlands and the other in the Green Bay-Lake Winnebago area. However, this analysis does not provide an answer to the question of whether these two populations are interacting in any significant fashion. The lack of Wyandotte chert in Burnt Rollways components suggests that any interaction may be limited and one-way (unlikely given the Maussian obligations involved), but to fully address this question we must turn to an analysis of copper materials. Copper trace element analysis can distinguish individual artifacts and identify their potential source associations to a greater resolution than lithic source analysis.

Copper

Ideally, an analysis of this sort would attempt to identify the geological provenance of individual artifacts, and then, as with the lithics discussed above, look to identify meaningful patterns in the utilization of sources. Such an analysis would first attempt to characterize the chemical trace element signature of individual sources, then look to assign artifacts to those sources based on important between-source variation in elemental composition. Comparisons between sites could then potentially identify meaningful patterns in the utilized sources and might suggest degrees of interaction. However, this approach relies on several assumptions, including that sources are adequately known and that variability within and between sources is accurately characterized by the available samples.

Such assumptions may be false. Only a handful of geological sources have been sampled in the Lake Superior basin, including the Champion, Centennial, and Minesota mines on the Keweenaw Peninsula, the Snake River valley in eastern Minnesota, and Isle Royale and Michipicoten Island in the northwestern and northeastern portions of Lake Superior. Fewer still outside the Lake Superior region have been adequately sampled. Even if the trace element variability of these sources is adequately characterized by the available samples, they may not—indeed, likely do not—represent the sources used prehistorically since many of these samples were collected from within modern mines (Rapp et al. 2000). Such sources were unavailable prehistorically and research at Duck Lake and other sites in the region suggest that Archaic populations were instead exploiting copper from secondary sources such as glacial landforms and lag deposits in stream valleys. Few of these sources have been sampled and characterized.

Thus we are left to treat each site as an independent source and copper from one site is then compared with every other site. This approach avoids *a priori* assumptions about known and adequately characterized sources by recognizing that each site represents the collective source utilization of a population, and that the chemical composition of each site will then reflect the geological source(s) utilized by that population through time. Elemental composition can then be compared between sites to determine differences that reflect variability in source utilization. Individual copper artifacts can also be used to determine if their elemental composition best matches the site in which they were found, or if they fit more closely with the composition of copper from other sites. If the latter is found, it *may* indicate that interaction between those communities occurred through which copper was moved from one to the other. Conversely, if the chemical composition of copper from one site does not overlap with that of another site, it strongly suggests that interaction was not occurring between those communities.

Discriminant Function analysis is used here to identify patterns in the composition of copper by site, and to assess the probability that individual copper artifacts are best affiliated with the site in which they were found or with other sites in the sample. Using elemental composition of the copper artifacts as data, this analysis proceeds in two steps. First it assumes that copper artifacts are best associated with the site in which they were found and then builds a compositional profile of each site from the elemental composition of the constituent artifacts. Second, it then attempts to use the elemental composition of each artifact to assign a probability that it best fits the compositional profile of one site or another. If the analysis matches every artifact to its original site, it is said to have 100 percent reclassification. Less than 100 percent indicates that the composition of some of the copper artifacts best fit sites other than the ones in which they were found, and thus may have been traded from one site to another. Using this method, each artifact becomes a measure of the probability that it was produced in one community and was subsequently moved through some means to another—or that it was produced from a source utilized by multiple communities.

LA-ICPMS produced data for 37 elements from 91 copper artifacts representing the Duck Lake, Burnt Rollways, Rainbow Dam East and Rainbow Dam West sites of the Burnt Rollways phase, the Reigh site, and the Red Ocher associated sites of Riverside and Thiensville (Table 8.1).

Each artifact was sampled twice to account for variability within the sample. Exclusion of measures of elemental copper and other elements either poorly represented or previously found to not correlate with source variability reduced the data to 30 elements, and this data was then power-transformed using the method in Formula 8.1 to enhance normality.

The power-transformed elemental data were then used in a Discriminant Function analysis in which six functions were found to account for 100 percent of the variability within the data (Table 8.5). Reclassification succeeded in correctly reassigning 96.6 percent of the artifacts to their original sites, revealing that copper in each site is relatively homogenous in composition and that sufficient variation is present to distinguish between them.

Plotting the individual artifact scores for factors one and two (Figure 8.4) reveals that copper from sites of the Burnt Rollways phase is internally distinct, and demonstrably different in composition from that of the Reigh, Riverside, and Thiensville sites, and that the latter sites overlap considerably in elemental composition. While this difference is due to the covariation of multiple elements, it can be illustrated through a plot of aluminum (Al) to iron (Fe) (Figure 8.5). Burnt Rollways populations were exploiting copper sources with higher aluminum to iron ratios than their downstream contemporaries around Lake Michigan.

The difference in utilized copper resources between Burnt Rollways sites and Reigh-Riverside-Thiensville again supports the conclusion that these are separate populations—one centered in the Northern Highlands and the other along the western shore of Lake Michigan. But unlike the earlier lithic analysis, we may now address the question of whether these two contemporary and neighboring populations were interacting in any fashion that featured the exchange of copper from one to the other. In our earlier discussion of copper distribution in the Midcontinent, it was demonstrated that Burnt Rollways was producing copper artifacts and using them locally, while the Riverside community was utilizing copper it acquired through an undetermined means to participate in regional interactions that best fit a prestige-chain model. With this analysis, we now have the means to determine if Riverside was obtaining its copper through interaction with Burnt Rollways communities nearer the geological copper sources, or through other means yet undermined.

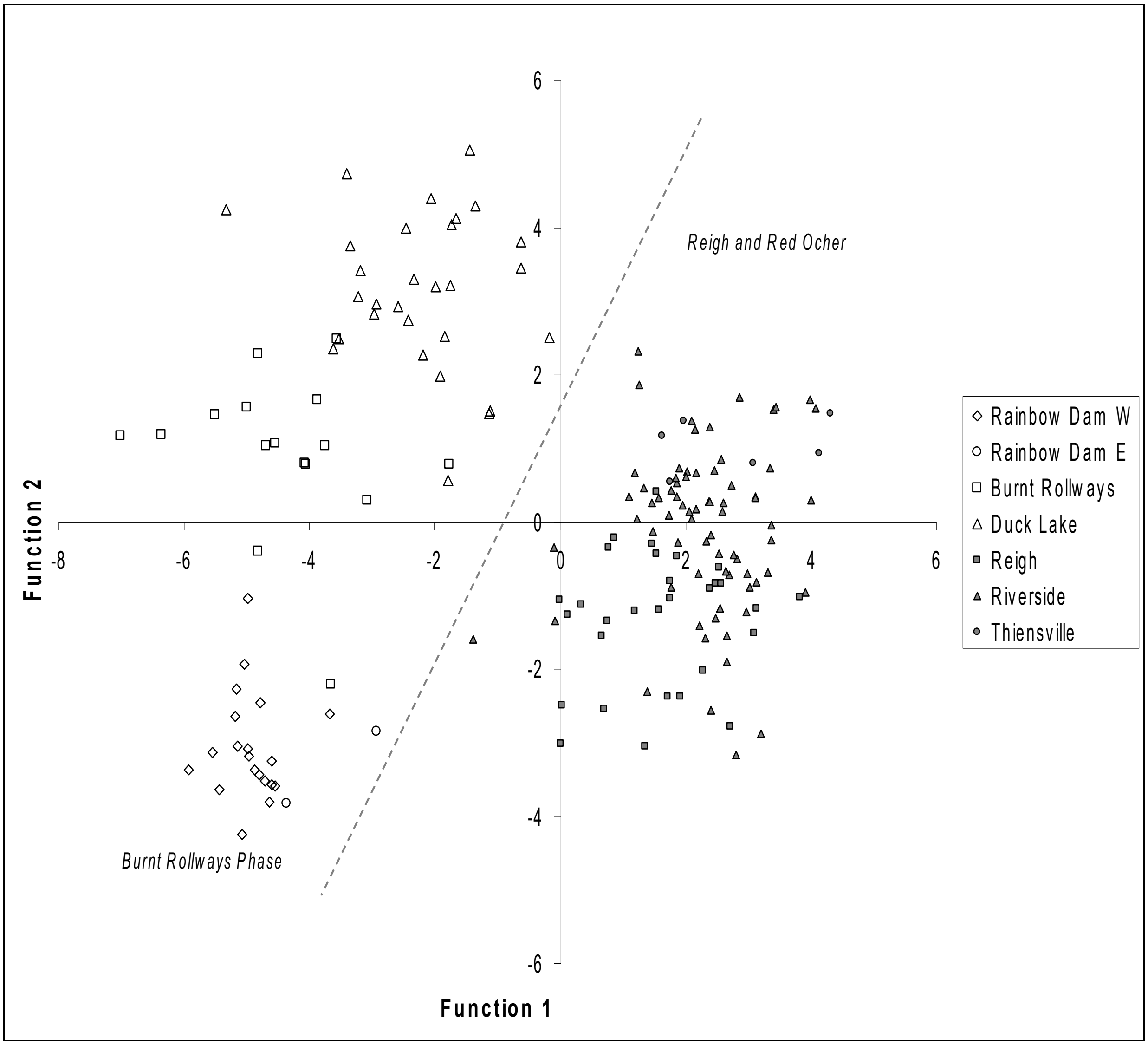


Figure 8.4. Discriminant Function scores of copper elemental composition. The dashed line separates the elemental composition scores for copper from the Burnt Rollways phase components from that of the Reigh Phase and Red Ocher components.

Discriminant Function analysis again provides the method by which this issue can be addressed. By creating compositional profiles for each site, this analysis then uses *Mahalanobis distance*, or a kind of Euclidian distance in multi-dimensional space where each factor represents a dimension, to assign a probability that a given artifact best fits the compositional profile of its original site or that of other sites. Previously, it was noted that the Discriminant Function analysis correctly reclassified 96.6 percent of the artifacts to their original sites. The remaining 3.4 percent represent cases in which the artifact best matches the elemental composition of a site other than its own.

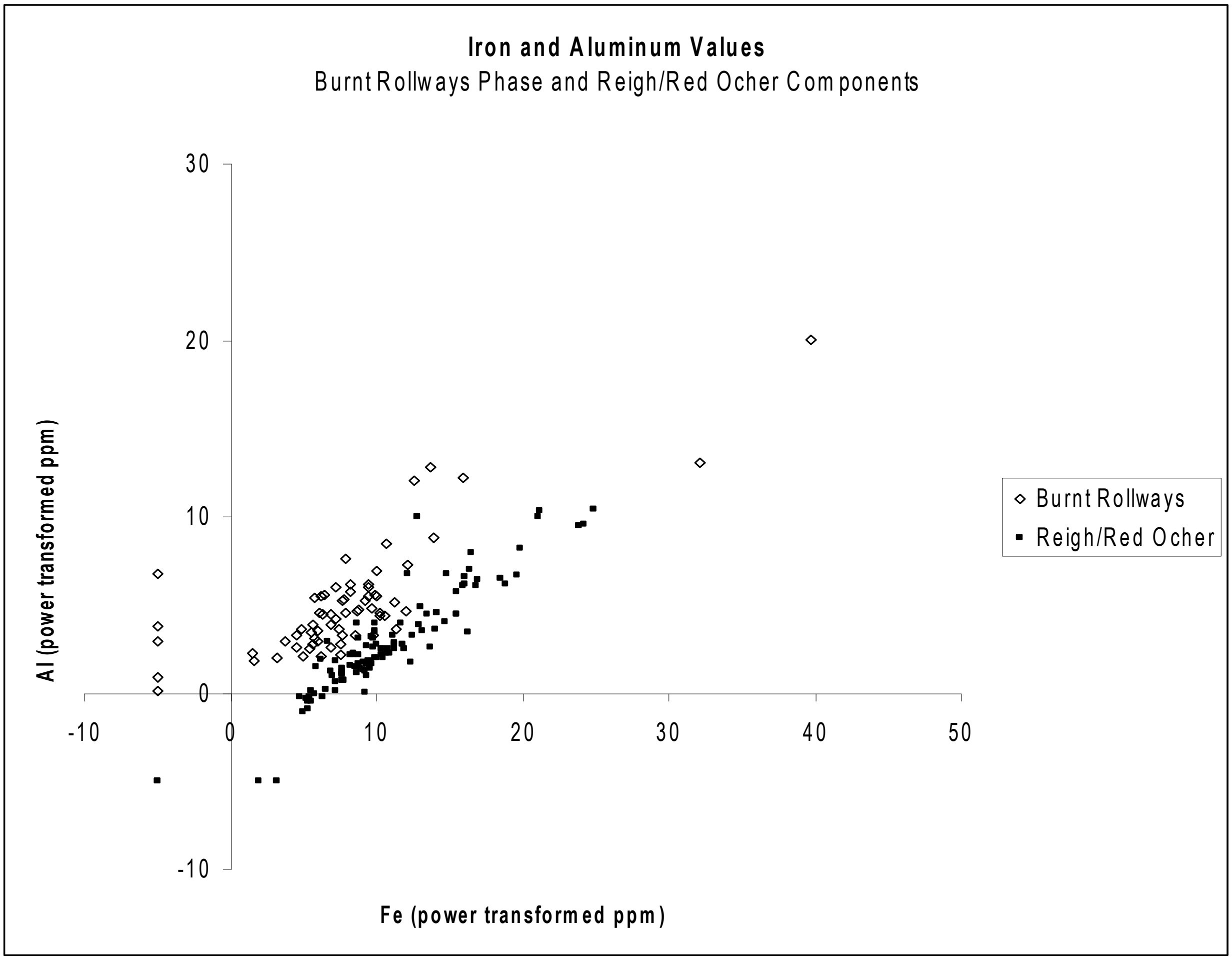


Figure 8.5. A comparison of Aluminum vs. Iron values for Red Ocher/Reigh copper and Burnt Rollways phase copper.

Table 8.5. Frequency of reassignment of copper artifact from one Archaic phase to another, based on Discriminant Function analysis of copper elemental composition.

Original Associations	**Reassigned Associations**		
	Burnt Rollways Phase	*Reigh Phase*	*Red Ocher*
Burnt Rollways Phase	100.0	0.0	0.0
Reigh Phase	0.0	93.3	6.7
Red Ocher	0.0	2.6	97.4

The issue is whether copper is moving between communities of the Burnt Rollways phase and their downstream contemporary neighbors at Reigh, Riverside, and Thiensville. It thus becomes useful to examine the results by phase (Table 8.5), and when we do we find that 100 percent of the Burnt Rollways phase copper artifacts were reclassified to sites of the Burnt Rollways phase. Most of the copper from Riverside and Thiensville is also reclassified to those two sites participating in the Red Ocher interaction network, but 2.6 percent (n=2) of the copper artifacts are more closely associated with the compositional profile at Reigh and none is found to fit with the Burnt Rollways phase. Likewise, most of the Reigh copper is reclassified to Reigh, but 6.7 percent (n=2) better fits the compositional profile of Riverside-Thiensville while none fits the compositional profile of Burnt Rollways.

The Riverside and Thiensville communities are sharing similar copper sources, and quite possibly sharing copper through interaction and exchange. Their predecessors at Reigh were utilizing similar, and at times overlapping, copper resources to produce the copper beads and other items buried there. However, neither of them was significantly obtaining copper from, or sharing copper with, the upstream communities of the Burnt Rollways phase.

But what are these sources? If Riverside is not obtaining their copper from their neighbors, what is the source of their copper? Can the available data identify where Late

Archaic populations are obtaining copper? First, we can note that those sites featuring copper production activities, such as Duck Lake, Rainbow Dam East, and Rainbow Dam West, are mostly located south of the primary geological sources on the Keweenaw Peninsula and in the vicinity of glacial features that may contain copper in secondary contexts. As shown in the previous chapter, unworked native copper at these sites is most consistent with secondary sources and less consistent with vein copper obtained from bedrock sources (Hill 2006, Chapter Seven; Moffat and Speth 1999). Throughout the following analysis, the reader should keep in mind the potential problem posed by having most of the geological sources represented by modern mines in the primary source area while the available evidence suggests that Archaic populations were utilizing the more accessible copper from secondary sources.

Table 8.6. Copper source areas by site.

	Burnt Rollways		**Duck Lake**		**Rainbow Dam East**		**Rainbow Dam West**		**Reigh**		**Riverside**		**Thiensville**	
Source	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**
Lake Superior	12	75.00	25	86.21	0	0.00	15	75.00	18	60.00	59	77.63	6	100.00
Maritimes	0	0.00	2	6.90	0	0.00	0	0.00	0	0.00	2	2.63	0	0.00
Pennsylvania	4	25.00	2	6.90	2	100.00	5	25.00	12	40.00	15	19.74	0	0.00
Total	16	100.00	29	100.00	2	100.00	20	100.00	30	100.00	76	100.00	6	100.00

The Lake Superior region is perhaps the richest source of native copper in North America, but it is not the only source. Copper is also found in the Maritime Provinces of Canada, in the Appalachians of eastern North America, in the Southwest, Alaska, and elsewhere in North America (Rapp et al. 2000). In the first analysis, we might ask if the Archaic copper studied here has its origins in the Lake Superior region or if it best fits copper sources elsewhere. Again, Discriminant Function analysis allows us to create compositional profiles of each of the source regions, and to compare the elemental composition of copper artifacts with those source profiles.

Doing so reveals that 75.4 percent of the copper artifacts in the sample are attributed to Lake Superior sources, 2.2 percent to sources in the Canadian Maritimes, and 22.3 percent to Pennsylvania sources (Table 8.6)

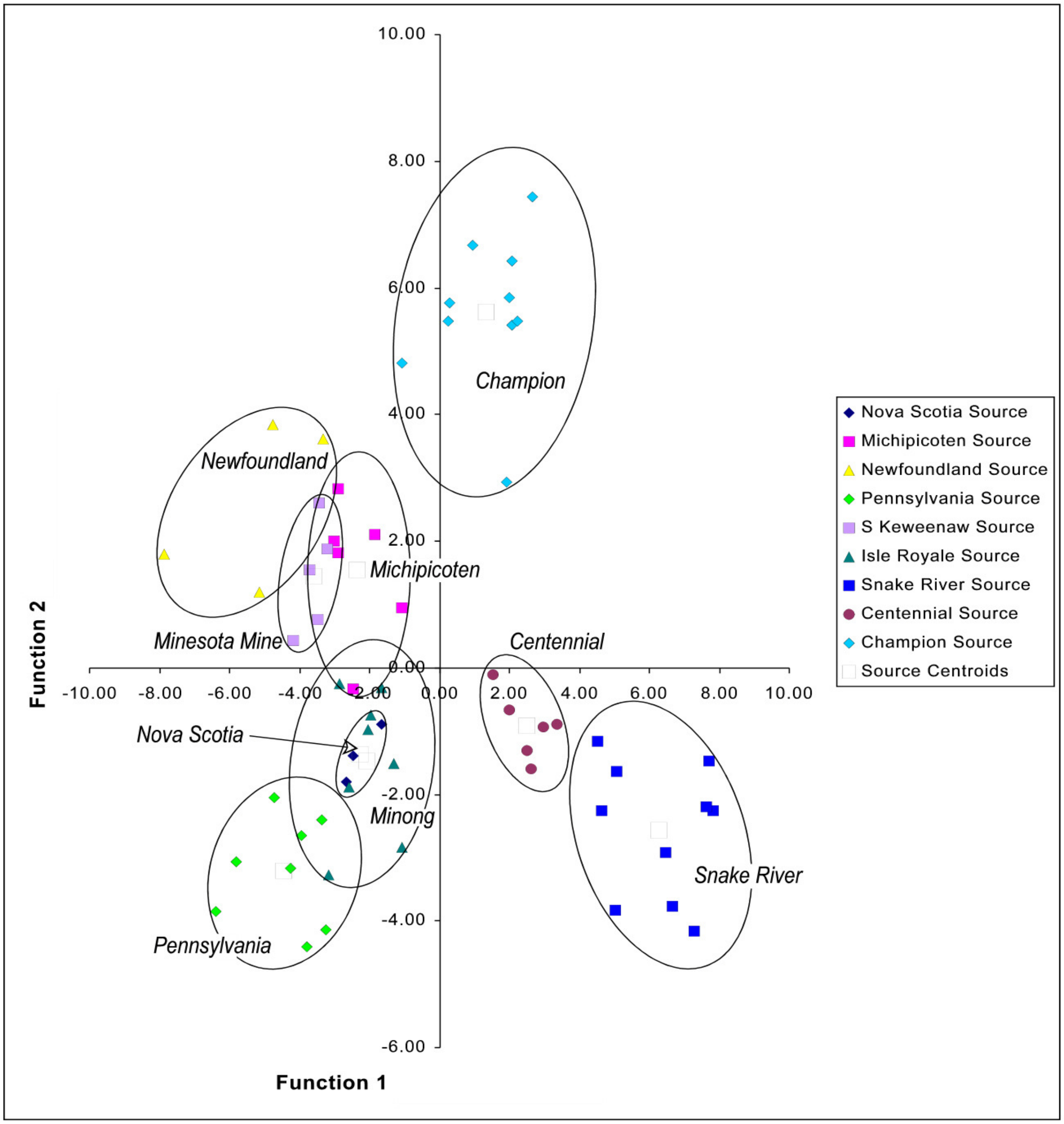


Figure 8.6. Plot of discriminant function scores for eastern North American copper source samples.

The attribution of copper to sources in Pennsylvania and the Maritimes may be accurate, or it may be due to poorly defined source data in the Lake Superior region and to overlapping characteristics between Lake Superior sources and those other eastern North American sources. I favor the latter interpretation. As shown in Figure 8.6, the compositional profiles of copper from the Minong Mine on Isle Royale overlap with those from both Pennsylvania and Nova Scotia. Several attempts were made to differentiate Lake Superior from other sources in eastern North America with limited success, but additional efforts are beyond the scope of this project and will be addressed in later studies. Clearly *most* of the copper in this study originates from Lake Superior sources. It is not possible to categorically state that *all* of the Archaic copper in the study originates from Lake Superior sources, but it is well within the range of possibility and may even be likely given the proximity of these sites to the sources around Lake Superior.

As Figure 8.6 illustrates, the existing Lake Superior sources in this sample are sufficiently different from one another so as to make further sourcing efforts attractive. Copper elemental data from each of these Lake Superior sources was used in yet another Discriminant Function analysis to create compositional profiles for the Lake Superior region. Five discriminant functions were identified; the first three of which characterize 64.5 percent, 18.7 percent, and 8.9 percent of the variance respectively, and successfully distinguish each Lake Superior source (Figure 8.7).

Comparing copper from the Burnt Rollways phase to these source profiles shows that it is most often attributed to the Minong Mine on Isle Royale and has secondary associations with the lag deposits along the Snake River in eastern Minnesota and with primary sources on the Keweenaw Peninsula (Table 8.7, Figure 8.8). However, these attributions are not without problems. When copper from each site was examined individually and compared to the source profiles, it was often found to weakly cluster with known sources or only cluster near known sources, as can be seen in Figure 8.9. It is likely that much of this copper is from secondary sources—as suggested by excavations at several of these sites—and that extensive additional sampling of secondary sources is needed to better characterize them and to understand Archaic source utilization in the Northern Highlands.

Similar caveats apply to both Reigh and Riverside. At Reigh, copper is most often attributed to the Minong mine on Isle Royale, as well as to Michipicoten Island and the Minesota and Centennial mines on the Keweenaw Peninsula (Table 8.7). Some degree of clustering around the Minong, Michipicoten, and Centennial sources wa noted, yet the Reigh copper can be distinguished from these by examining scores for discriminant functions 1 and 3.

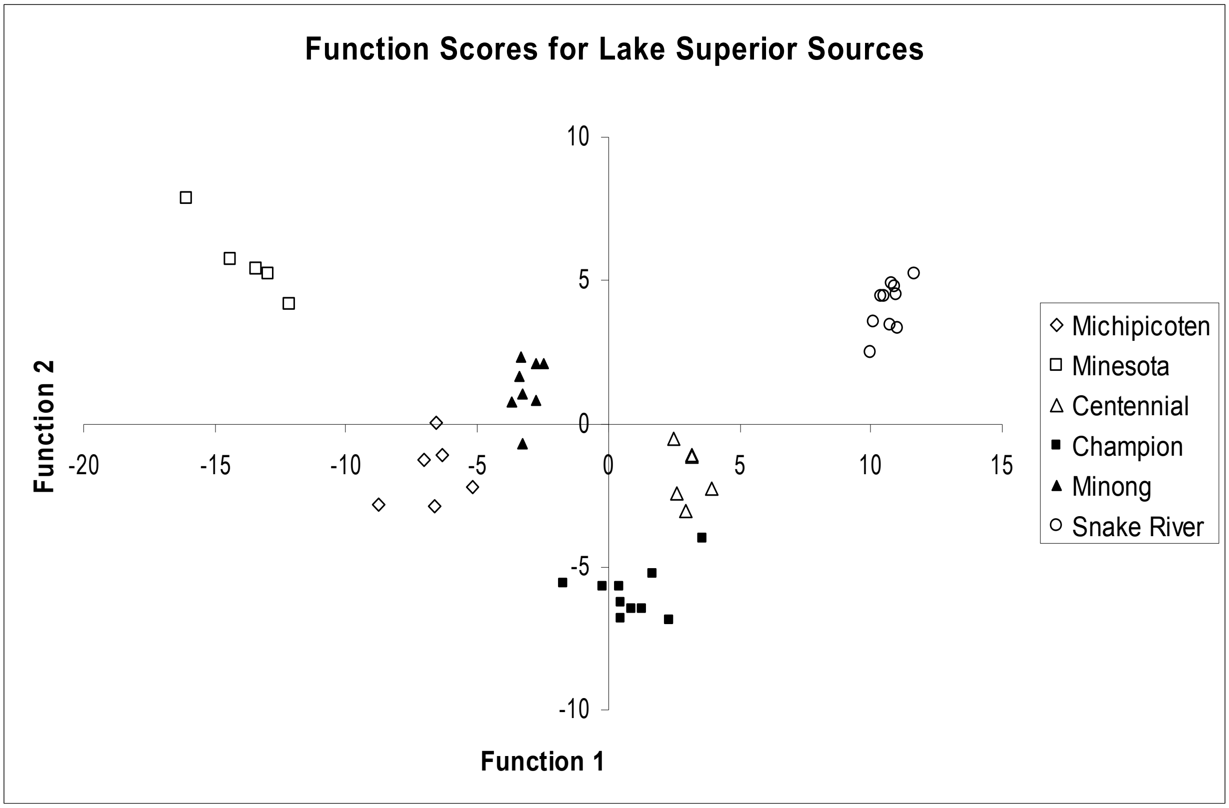
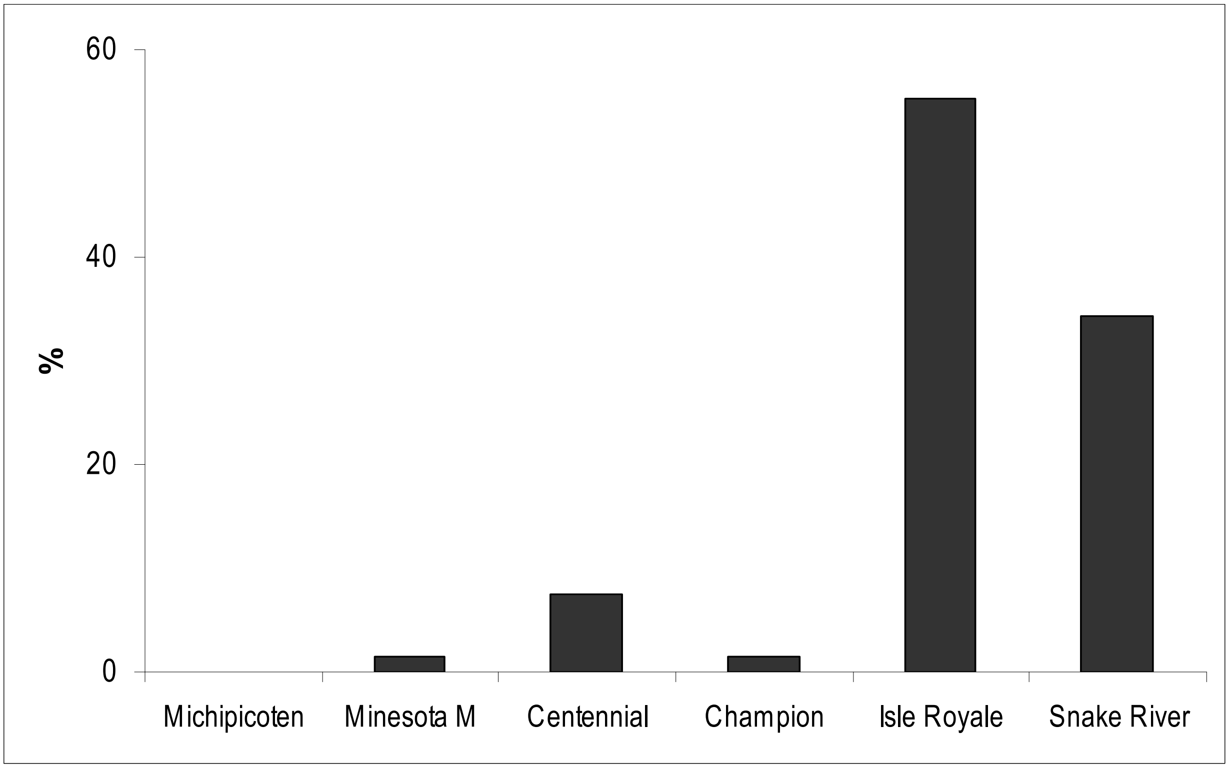


Figure 8.7. Discriminant function 1 and 2 successfully distinguish between Lake Superior sources.



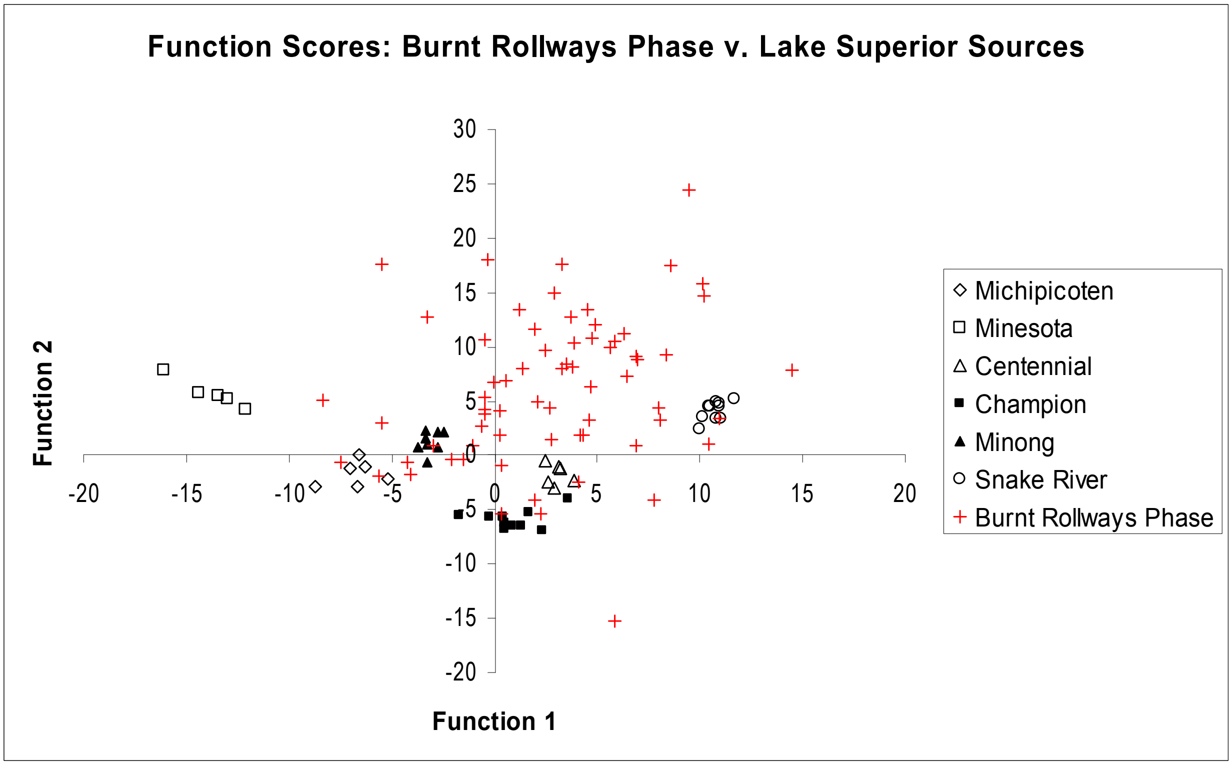


Figure 8.8. Top: Composite source identification for copper artifacts from Burnt Rollways phase components; Bottom: plot of discriminant function scores of Burnt Rollways phase copper versus the scores of Lake Superior copper sources.

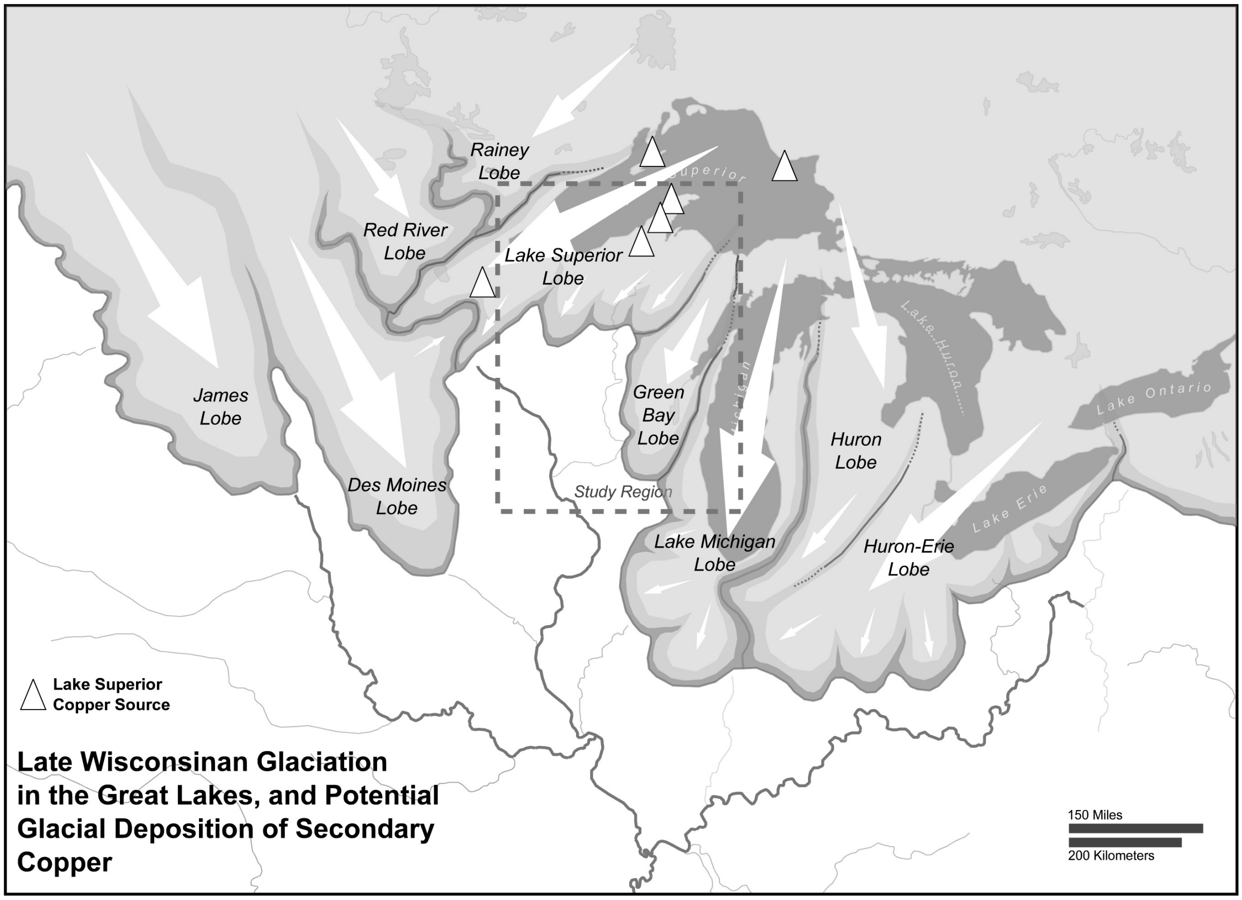


Figure 8.9. Late Wisconsinan glacial lobes in the Great Lakes, and the potential areas of secondary deposition of copper from the sources utilized in this study

Riverside copper artifacts are attributed to all of the Lake Superior sources used in this study (Table 8.7). Most often, Riverside artifacts are attributed to sources on Isle Royale and Michipicoten Island, but the Snake River and Keweenaw sources are also well represented. Yet again, the scores for functions 1 and 3 distinguish Riverside copper from all of the available sources, except for a possible association between a few artifacts and the Minong Mine source on Isle Royale.

It appears that a direct attribution of most Archaic copper to any known source in this sample is an elusive goal. While the artifactual copper is consistent with Lake Superior copper, and is largely inconsistent with other sources in eastern North America, it has proven difficult to directly connect Archaic copper with the known Lake Superior sources. The most parsimonious explanation is that Archaic populations, while obtaining copper in the upper Great Lakes, were not utilizing the sources employed in this study. Given that the copper that characterizes Isle Royale and all the Keweenaw sources was obtained from historic mines (Rapp et al. 2000:19-26) and that secondary sources are poorly represented in the available sample, this result is not surprising.

Table 8.7. Source assignments for Archaic copper.

	Frequency of copper source assignment					
Site	*Michipicoten*	*Minesota Mine*	*Centennial*	*Champion*	*Minong (Isle Royale)*	*Snake River*
Rainbow Dam West	0.00	0.00	15.00	5.00	75.00	5.00
Rainbow Dam East	0.00	0.00	0.00	0.00	100.00	0.00
Burnt Rollways	0.00	0.00	6.25	0.00	50.00	43.75
Duck Lake	0.00	3.45	3.45	0.00	41.38	51.72
Reigh	6.67	3.33	3.33	0.00	86.67	0.00
Riverside	19.74	2.63	2.63	11.84	55.26	7.90
Thiensville	50.00	0.00	16.67	33.33	0.00	0.00

Secondary copper deposits originate largely through glacial action and later movement by erosion and stream action. As glaciers scoured the Lake Superior basin, they removed copper from its primary deposits along the Lake Superior rift and transported copper nuggets and boulders to the south and southwest (Figure 8.9). The origins of copper in glacial deposits should roughly conform to the bedrock outcrops over which each glacial lobe moved. Thus, we should expect to see differences between the copper obtained from glacial deposits along the Green Bay lobe in eastern Wisconsin and that obtained from the glacial deposits of northern and northwestern Wisconsin and the Upper Peninsula. It is this likely variation in secondary sources that is thought to be the cause of variation in elemental composition between copper obtained and used by the Burnt Rollways phase populations and that used by Red Ocher and Reigh populations to the southeast. Additional sampling of copper from these deposits will be necessary if we expect to directly attribute artifact copper to geological sources, and will be the focus of future efforts.

Conclusions

Analysis of lithic and copper sources has now answered the last questions posed in this study. We have seen that copper and lithics are important components of regional exchange systems and the display of social position in Late Archaic societies. In the previous chapter, it was demonstrated that this native copper was obtained and copper artifacts were produced by populations of the Burnt Rollways phase in the Northern Highlands, and that copper in that area was largely used and circulated locally. However, Riverside was found to be one end of a very different system in which copper appears to have been exchanged as a prestige good with communities to the south. The primary issue of this chapter then became one in which the relationship between the Burnt Rollways phase and Riverside and Reigh was explored as a possible source of the copper used in the extensive Red Ocher interaction network of which Riverside was a part.

Were Burnt Rollways and their downstream contemporaries simply different seasonal settlements of the same community which featured dispersal and later population aggregation? This would be one way in which copper obtained in the Northern Highlands could have found its way into the exchange systems represented at Riverside. Another would be through trade and interaction between separate populations, one in the Northern Highlands represented by Burnt

Rollways and the other in the Green Bay-Lake Winnebago area represented early by the Riegh site and later by Riverside.

Looking at the lithic resource utilization of Burnt Rollways, Reigh, and Riverside provides us the first clue. While these phases utilized similar lithics for tool production, sufficient differences were found to suggest that they represent at least two different populations. Burnt Rollways emphasized the use of Prairie du Chien chert over Galena; Reigh and Riverside did just the opposite. Burnt Rollways obtained small quantities of exotic lithics as tools from the upper Missouri River valley far to the west and the Lake Ontario region far to the east; Riverside obtained large numbers of exotic and standardized bifaces through formal interaction with communities in the Ohio Valley far to the south. These bifaces, and even the raw materials from which they were produced, are absent from the Burnt Rollways communities studied here. These results suggest that Burnt Rollways and their downstream contemporaries at Riverside, and earlier at Reigh, represent different populations. The lack of Wyandotte chert in Burnt Rollways sites suggests that interaction between these populations was limited, but this cannot be demonstrated with the lithic data alone.

Analysis of the utilization of copper resources does demonstrate this. Copper trace elements vary from source to source, and LA-ICPMS analysis was conducted with copper artifacts from Burnt Rollways sites, Riverside and Thiensville, and Reigh. The results clearly demonstrate that Burnt Rollways on one hand, and Riverside-Thiensville-Reigh on the other, were utilizing non-overlapping copper resources and that copper from one population was not found with the other. This analysis shows they were not interacting in any appreciable way that would move copper Burnt Rollways communities to Riverside or Reigh.

Attempts to identify these copper sources met with limited success. Most, if not all, of the copper in these sites is consistent with sources in the Lake Superior region. However, it appears that source samples largely obtained from deep underground in historic and modern mines do not adequately characterize the sources used by Late Archaic populations. Excavations at Duck Lake and other sites indicates that much of the copper used for artifact production at this time was obtained from secondary sources such as glacial till and lag deposits along stream valleys. These sources are not well represented, and additional efforts to sample and characterized these sources are greatly needed.

Standing on the Duck Lake site all those years ago, I began to wonder about the journey that copper was to have taken. Now we have an answer, it was not going far. While copper at Riverside—perhaps obtained from secondary sources along the glacial landforms associated with the Lake Michigan and Green Bay glacial lobes—was used to signal social position and functioned in formal exchange and interaction networks, copper at Duck Lake was not a part of this system. In terms of the model outlined in Chapter Two, Burnt Rollways communities lacked access to those social networks, not because geographic distance imposed too high a cost but because social distance did. Differential access to the benefits of formal exchange networks is not just present *within* Late Archaic communities, but *between* them as well.

CHAPTER NINE

SUMMARY AND CONCLUSIONS

When I stepped out of a Forest Service truck on that warm day in the summer of 1994, I had little idea of where such seemingly simple questions would lead me over the coming years. I simply saw flakes of chert and pieces of copper at the Duck Lake site and wondered about their origins, how they got there, and where they might have been going. However, these simple questions led to larger issues—issues of how people exchange items, what exchange means, and how it functions to create relationships and benefits. As I pursued those questions deeper into the literature I learned that traditional anthropological views of exchange and social interaction had correlates in evolutionary theory, and that a synthesis of the two was possible and useful.

The model that results from this synthesis builds on a foundation established by Marcel Mauss (1990), who observed that humans have obligations—obligations to give, obligations to receive, and obligations to reciprocate. Mauss' obligations fit with evolutionary theory's explanations for the evolution of cooperative behavior, in particular Hamilton's (1964) inclusive fitness theory and Trivers' (1971) theory of reciprocal altruism. The resulting synthesis, presented in Chapter Two, makes several predictions that have been examined throughout this volume. First, it indicates that at certain threshold points, some individuals find that participation in exchange networks will provide benefits in the form of access to non-local materials and information, enhanced social status, positions as brokers to needed goods and information within their home communities, access to potential spouses, and reduced risk. But participating in exchange networks is costly. Materials must be procured or produced, relationships built and maintained, and obligations met. These activities carry costs; costs of energy expended, time spent, other opportunities forgone, and risk of failure. Due to factors such as existing consanguine and affinal relationships, access to necessary resources, history, personal abilities, and others, some individuals will be in a position to afford the benefits of exchange before others. In other cases, entire communities may find it too costly, due to geographic distance, resource limitations, or social factors. As some individuals find themselves able to gain benefits through exchange, we expect to see such interaction develop and expand, and those individuals with access gain additional benefits. Communities start to feature "haves" and "have-nots," while the "have-nots" gain secondary benefits through those with connections to outside communities.

But reciprocal altruism indicates that exchange is risky. The benefits of exchange are built on a foundation of trust, but how does trust first develop? How can trust be established between strangers from different communities? One way is through the development of standardized means or materials of exchange that clearly and distinctly signal that the participants can be afforded some degree of trust. The development of exchange and interaction networks may well be accompanied by the establishment of shared ritual and symbolism that provides safer opportunities for interaction.

As interaction proceeds, trust may be built between participants. If so, access to the benefits of interaction increases according to the equation for reciprocal altruism. This may create opportunities to increase the scale and frequency of interaction, leading to more materials moving over larger distances between participants. However, trust can be lost as well. If this occurs it can be expected to lead to behaviors including negative reciprocity, conflict, and even violence between communities.

Growing trust, building relationships between communities, formalizing materials and methods of interaction, risk, and the benefits gained through exchange and interaction networks all have great potential for creating social change within participating communities. In particular, the opportunity to build and maintain important relationships through marriage leads to the prediction that the social roles individuals, particularly women and children, will change to emphasize the growing benefits gained through relationships.

These predictions follow directly from the synthesis developed in Chapter Two, and they form the core of a theme that winds its way through this study. While the study could apply and test this theory anywhere that exchange between small-scale communities occurs or has occurred in human history, it remains true to its origins and examines how exchange may lead to growing regional interaction, enhanced ritual activities, and increasingly complex social organization in the Late Archaic of the western Great Lakes.

This study area is bounded on the north by Lake Superior, on the east by Lake Michigan, on the west by the Mississippi Valley. Rivers flowing southward from the Northern Highlands near Lake Superior form natural travel routes across the area to the Mississippi Valley in the west and Lake Michigan in the east. Lithic resources are limited in the north, but various visually distinct lithic materials are described from the region—important information if we wish to trace the different use and exchange of stone tools and raw materials. The Lake Superior region in the north is shown as a source of native copper which was used for the production of tools and ornaments during the Archaic.

Between 4000 and 2000 years ago, several groups were at home in this region. Early on, Middle Archaic populations were utilizing a cemetery at the Reigh site near Lake Winnebago, while similar populations—formerly known as Old Copper—were using different rituals and mortuary practices to bury their dead in the lower Wisconsin and Mississippi Valleys. After 3600 years ago, changes occurred in technology and social structure that led to the period known as the Late Archaic. In the southwestern part of the region, the Preston and later Durst phases occupied the bluffs and valleys of the Driftless Region. Along the western shore of Lake Michigan, other Late Archaic societies began participating in a larger system of interaction and exchange known as Red Ocher. The best known and researched site of this population is the Riverside cemetery on the western shore of Green Bay. There, several individuals were buried with elaborate offerings of exotic bifaces, copper beads, and other materials while most people were buried with few items or even none at all. Far to the north, the Burnt Rollways phase communities were living around the hundreds of lakes that form the headwaters of the region's major rivers. Burnt Rollways communities were located near the primary source of copper, and excavations at several of their sites have shown us that they were producing copper artifacts such as awls, beads, and projectile points.

During this Late Archaic period, trade, ritual, and exchange become more elaborate and extensive in the Midcontinent. This is a time of change, when small-scale societies begin to employ exchange and interaction networks to provide benefits, when social systems appear to feature increasing complexity and the development of classes of individuals with distinctly recognized social position. Ritual, particularly mortuary ritual, becomes more elaborate, and goods are exchanged in apparently standardized form from the Ohio Valley to the upper Great Lakes. It is time of change, and exchange is a significant aspect of this change—it is an ideal case for testing the model developed in Chapter Two.

To test this I examined changes in the scale and frequency of exchange and interaction from the late Middle Archaic through the Late Archaic. Grave goods at the Middle Archaic

Reigh and Late Archaic Riverside sites were tabulated to provide the data on the frequency of interaction, and sourcing of these items provided a measure of the distance to their source. Using these two measures, it was demonstrated that the majority of the 125 items buried with a minimum of 45 people at Reigh could have been obtained within 200 miles of the site. A sandal-sole gorget, made of marine shell and characteristic of the Glacial Kame interaction network around Lake Erie (Cuningham 1948) suggests tenuous distant interactions that may presage developments seen later.

Later at Riverside, a vastly expanded system of interaction is apparent. There, 1264 items were buried with a minimum of 51 people; a tenfold increase in the numbers of goods present. The scale of interaction expanded as well; while many of these items at Riverside could have been obtained within 200 miles of the site, over 10 percent were obtained from the lower Ohio Valley and even more distant connections are indicated by the very limited presence of Knife River Flint, Obsidian sourced to Yellowstone (Pleger 2000), and marine shell beads. If this does not represent the origins of interaction and exchange (the individuals buried with the sandal-sole gorget at Reigh represents an earlier development), it certainly represents a significant expansion in the frequency, volume, and scale of interaction during the Late Archaic. This is consistent with the model's prediction that if trust is established between individuals and communities through repeated exchange, the benefits become less costly and exchange networks become more robust.

Next, differential access to these benefits was explored. The model predicts that some individuals will gain access before others, and through exchange and interaction those individuals will gain individual benefits as well as provide benefits to their communities (thus gaining even more benefits). The Riverside cemetery provides the means to determine if the

Late Archaic is a time in which we can see the development of inequality; do we see the appearance of “haves” and “have-nots?” If all share equal access to exchange benefits, the distribution of goods within the community should follow a normal curve. If some gain those benefits while others do not, the distribution of goods will follow a power-law curve (Bentley 2003, Bodley 2003). At Riverside, we found that locally available materials followed a normal distribution. All in the community have open access to local resources. However, two categories of items fit power-law distributions; exotic bifaces manufactured of Wyandotte chert and copper beads. The distribution of these items, featured prominently in the exchange systems of the Midcontinent, indicates that access was restricted to a few individuals in the Riverside community. As predicted, some individuals gained direct benefits from exchange and interaction, most did not.

Exchange is risky. Failed exchange interactions can lead to the loss of trust between communities, a loss that may lead to increased negative and agonistic behaviors and perhaps even aggression and violence. While the benefits of exchange accrue primarily to participants and only secondarily to the community, the risks of exchange are shared by all. The model predicts that the development of these exchange systems will be accompanied by rules that standardize exchange goods, the means and context of exchange, or both.

During the Late Archaic, large double pointed bifaces manufactured from Wyandotte chert were prominently featured in the exchange systems of the Midcontinent. Using 85 of these bifaces that had been buried with individuals at Riverside, it was shown that they were highly standardized with regard to the raw materials of production, the characteristics displayed such as banding and cortex that clearly indicated their origin, and metrics such as length and width. No debitage of the same material was found at Riverside, and I am unaware of any in the northern

Lake Michigan basin, suggesting these items were manufactured outside the region—most likely in the lower Ohio Valley of southern Indiana where the geologic source of Wyandotte chert is found. Furthermore, they were manufactured as sets in which metric attributes were highly consistent. Within these sets, coefficients variation for width and length are very low, consistent with measures that indicate production by specialists (e.g., Eerkins and Bettinger 2001). These Wyandotte bifaces are costly signals. They are manufactured from visually distinctive exotic materials, and their production features attributes that clearly indicate their authenticity. They are produced non-locally by specialists to clearly convey information over large social distances. The appearance of these symbols is consistent with the prediction of standardized exchange materials. These bifaces functioned, in part, to clearly convey authenticity and to reduce risk among participants in a large and diverse network of interaction.

While standardizing exchange goods and perhaps wrapping exchange in contexts of ritual may reduce risk, it does not eliminate the potential that trust will be damaged or lost. In these circumstances, conflict between communities is predicted and may escalate to inter-community aggression. Using mortuary populations and signs of trauma, it was demonstrated that aggression and violence did appear more frequently in Late Archaic populations. In one instance, excavation at the Convent Knoll site identified several young males who had been killed, mutilated, and haphazardly buried in a single pit (Overstreet 1980). The investigators interpreted this as the result of inter-community aggression or warfare, an interpretation that is not at odds with either the data or the model developed here. Examining the age and sex of mortuary populations demonstrates another trend that support the interpretation of increasing conflict. In the Late Archaic at Riverside, young adult males are significantly underrepresented. If they died at the same rate as earlier populations, they did so elsewhere or were not being interred the same as before. We might be tempted to speculate that they died in warfare and were not returned to Riverside for burial.

Social changes are expected to occur as exchange networks gain importance and provide opportunities for benefits. Exchange creates relationships built first on obligation and trust, but these relationships can be strengthened through intermarriage, as noted by Levi-Strauss (1969), Williams (1969), and others. These opportunities should lead to changes in the social roles of men, women, and children as opportunities to forge stronger relationships lead to changes in marriage rules, the social importance of children, and perhaps to the development of corporate groups. This change is explored in depth in Chapter Five, using data from the Middle Archaic Reigh and Late Archaic Riverside sites. Material goods buried with individuals at these sites are more than tools, ornaments, or debris; many are also symbols of beliefs, identities, values, and ideas. This expressive nature (sensu Befu 1977) of material items provides a means to examine underlying social structures and the roles of males, females, and children in Middle and Late Archaic societies.

At Reigh, these expressive items include beads, points, and “feathers” of copper, local lithic artifacts including large notched bifaces, antler and bone artifacts, and marine shell. Most of these items are found with adult males for whom they are interpreted to serve as symbols of social roles these individuals held in life. A subset of these goods, including the copper feathers and crane bills are associated with males who acquired prominent social position in Reigh society, and who are associated with adult females and children. Females have fewer expressive goods, but in at least one case a sandal-sole gorget of marine shell was buried with an adult female. Juveniles lack expressive goods, and are only found with them when they are buried with a male who has such goods.

Network analysis identifies males as central figures in Reigh society. Reigh is interpreted as largely egalitarian in which males gain social position through accomplishment, and perhaps through membership in age-grade or other societies associated with symbols such as bone tubes and crane bills. These social positions, symbolized by specific material items, affect the right to marry and to have children.

At Riverside, expressive material culture is dominated by copper and exotic lithic bifaces. Both have distinctive visual elements that facilitate their use as symbols to convey information to large groups and across large social distances (e.g., Wobst 1977). At Riverside, symbolism represents not male accomplishment, but instead is an expression of access to distant communities and relationships. In dramatic contrast to the earlier Reigh society, at Riverside these symbols are associated with adult females and children. Items such as copper beads, Wyandotte bifaces, copper celts, copper points, and copper crescents are conveying information about identity, social position, and relationships. Wyandotte bifaces are markers of relationships built over large social and geographical distances; copper artifacts suggest access to resources that may attract potential partners from those distant communities. Women and children use these goods to signal participation in a system where they gain status from their role in creating bonds of trust and interaction between individuals in distant communities. This localized expression of the Red Ocher interaction network may represent the development of exogamy and corporate groups such as lineages, changing social roles of females and children as builders and keepers of valued relationships, increasing scale of competition for reproductive opportunities from the local community in the Middle Archaic to between communities in the Late Archaic, the growing importance of social networks between communities that provide opportunities for interaction and intermarriage, and the use of standardized symbols in the negotiation of important transactions over larger social distances.

Many of those symbols are copper, and an examination of the Duck Lake site provides a rare view of how copper was obtained and copper artifacts were produced during this period. This small Late Archaic site, located immediately south of the Keweenaw Highlands in the southern Lake Superior basin, was used during the late summer to early fall by Burnt Rollways populations around 3400 years ago. Native copper was obtained from secondary sources such as an adjacent glacial moraine or as lag deposits along the East Branch of the Ontonagon River that runs along the eastern edge of the site. Production methods were remarkably simple; hearths and a small anvil stone were found that testify to the methods used. Yet here was the production of beads just like the hundreds found at Riverside, of conical copper points much like the ones found at many Middle and Late Archaic sites, and of stemmed copper points similar to those found buried with individuals at Riverside.

Were Burnt Rollways communities, such as Duck Lake, the source of the copper symbols that are found at Riverside and Reigh? Perhaps they even represent different seasonal aspects of a single community, which would move copper from the source area near Lake Superior to sites such as Riverside and Reigh. Revisiting the distributional study done by Fogel (1963) with new data indicates that copper is common in the Burnt Rollways communities of the Northern Highlands region, and its production and use appears to be largely local. Yet at greater distances, such as represented by Riverside and beyond, copper distribution best fits a model in which it is treated not as a common tool or ornament but as an item of prestige. Riverside appears to represent one point at which this prestige chain begins in the Midcontinent. So is Riverside obtaining its copper from the Burnt Rollways communities nearer the geological source?

The answer is found to be no. Examining the lithic resources utilized by Burnt Rollways sites, Reigh, and Riverside demonstrates that while they use many of the same resources, they use them differently. Burnt Rollways communities emphasize the use of Prairie du Chien over Galena chert, though both are common. Reigh and Riverside, using the same resources, emphasize Galena over Prairie du Chien chert. The use of distant lithic resources also indicates important differences between these groups. Burnt Rollways communities acquire distant resources from the eastern Great Lakes and northern Great Plains, and they acquire them as tools likely through limited down-the-line types of interactions characterized by limited and small-scale interactions between neighbors. Reigh has few lithics from distant sources, but Riverside has many which were acquired as formal and standardized symbols through intensive structured interactions over large social and geographical distances and with communities that have ties to the Ohio and Mississippi valleys far to the south. Burnt Rollways and Reigh-Riverside are different populations utilizing similar resources but in very different ways, and with different access to distant resources.

Trace element analysis of copper from these communities clearly demonstrates that Burnt Rollways is not the source of the copper artifacts that Riverside is using in its long distance interactions. The chemical composition of Burnt Rollways copper is distinctly different from that of copper used by Reigh, Riverside, and Thiensville. On the other hand, copper in Reigh, Riverside, and Thiensville is very similar in composition, suggesting that they were using one set of copper sources while their upstream neighbors in the Northern Highlands were using another.

Unfortunately, attempts to identify these sources met with only limited success. Most, if not all, of the copper appears to come from the Lake Superior basin, but the limited nature of source samples makes further identification difficult. Source samples derive from historic and modern mines, rather than from the secondary glacial and lag deposits that appear to have been used by the Archaic populations.

Conclusions

Excavations at Duck Lake led me to begin asking questions that eventually became the synthesis of two great traditions of thought concerning exchange and cooperative behavior. Using Mauss' obligations of giving, receiving, and reciprocation and evolutionary theories of cooperative behavior, this synthesis makes several predictions concerning when and how exchange and interaction networks may provide benefits to participants, and the effects that such exchange networks may have on participating societies. Each of these predictions was found to be supported by this test using the example here. Differential access within and between communities results from differences in the opportunity costs of using exchange and social networks as a source of benefits. Those with access to such networks gain significant benefits, while those that cannot afford the costs of participation must rely on those others to serve as brokers that channel secondary benefits to their communities. This status as broker also enhances participants position and importance in their home communities (Tooby and Cosmides 1986). The risk of such interaction with distant and different communities is offset by standardization of exchange materials so as to convey clear and costly signals that help to elevate trust during initial interactions. Yet risk is still present, and conflict occasionally results from failed interaction networks that degrade trust between communities.

The increasing role and importance of exchange as a source of benefits leads to social changes that characterize Late Archaic society in the study area. The increasing importance of females and children suggests that their role is changing to emphasize their value to building, strengthening, and maintaining important relationships between communities. Perhaps the changing role of females and children represents the development of corporate groups, exogamy, or other structural changes in Late Archaic society. If so, exchange is seen as a catalyst that promotes increasing social complexity as accomplishment is replaced by relationships as a source of social position and importance, effects that appear to continue into the Early and Middle Woodland societies of the Midcontinent.

Directions for Future Research

This journey began at the Duck Lake site, but it does not end there. As with much research, this study raises many additional questions that I have organized into four overlapping areas. These include 1) further exploration of the social changes that have been identified at sites such as Riverside during the Late Archaic, 2) understanding the production and interactions involved in the exchange of standardized material symbols such as Wyandotte bifaces and copper beads, 3) building the available source data for copper secondary sources to provide needed detail for future copper sourcing efforts, and 4) testing the reproductive fitness benefits of exchange among modern small-scale societies. Each of these is a logical outgrowth of the current study, and will provide opportunities to develop a greater understanding of exchange's role in culture process and change.

Significant social changes occurred during the Late Archaic, as we have seen in this study. A shift from male display of accomplishment to females and children using material symbols in death to display important relationships in life seems to accompany the increasing complexity of society and ritual during the Late Archaic and into the Early Woodland. What this means is less than clear. Two hypotheses are proposed, first that this shift represents the development of exogamy and marriage rules that require males to marry spouses from outside their community and that feature patrilocal post-marital residence. Females display social position gained by their consanguineal relationships outside the community; children display social position in part as signals of marriages arranged to individuals and families in other communities. This follows directly from the model proposed in Chapter Two, and in particular from the observations of Williams (1969) and Levi-Strauss (1969) concerning the strengthening of relationships through marriage. However, a second explanation involves the formation of matrilineal corporate groups. This would also explain the shift toward females and children displaying social identity and position; they are, in part, signaling affiliation with particular lineages within the community and children's propagation of those lineages into future generations. Which of these best fits the events of the Late Archaic in the western Great Lakes? The available data do not answer that question, but future research using DNA testing and strontium isotope studies of human remains may. Future research should focus on identifying the nature of relationships between females and children buried together at Riverside, and isotopic analysis of long bones may provide clues that address the question of post-marital residence patterns. Is it males who spent their youth in other communities and then come to Riverside as adults, or the other way around?

Second, this study has examined the production and distribution of copper from its source to its entry into a regional system of interaction with some limited success. However, a second significant material symbol is also important in Late Archaic interaction—standardized bifaces often produced from Wyandotte chert. In this study, it was proposed that these bifaces were manufactured near the source of Wyandotte in the Ohio Valley, and then traded out to communities and individuals as far away as the northern Great Lakes. Mary Ellen Didier (1967) studied the distribution of some of these finished bifaces, but their production is not well known. Where and why were they being produced? How they functioned at the far end of this interaction network may have little to do with how they were perceived and needed by those who produced them. To understand how, why, and where these bifaces were produced and how they function in those societies, future research must examine Archaic sites in the lower to middle Ohio Valley in Indiana and Kentucky. Distribution studies of Wyandotte debitage would also be useful in determining the production locales for these bifaces, and should focus on the period between 3000 and 2000 BP and the region between the Ohio Valley and Lake Michigan. Other bifaces, Adena points and other large stemmed items, were produced from Burlington chert. What is the role and meaning of these items? They function differently from Wyandotte bifaces, and are often found as individual artifacts. Additional research should address questions concerning the production, distribution, and various meanings of these items as well.

Third, despite decades of research by George Rapp and his colleagues (Rapp 1990; Rapp et al. 1980, 2000), we still have not achieved the goal of reliably sourcing copper artifacts. As discussed in Chapter Eight, much of this is due to a lack of reliable source samples and the problems presented by secondary sources such as glacial moraines and lag deposits in streams. Chemical composition analysis of copper provides a tool for unprecedented analysis of the actual functioning of prehistoric interaction networks during the Archaic, but poorly defined sources prevent us from achieving that goal. Future research should be directed at sampling copper from defined glacial moraine features associated with the known late Wisconsinan glacial lobes in northern Wisconsin and the Upper Peninsula. We can expect that copper in these secondary sources should vary from one landform to the next, corresponding with the variation in primary sources over which these glaciers advanced. Metal detector surveys of moraines and gravel bars in streams, and subsequent elemental and isotopic analysis of the resulting copper samples, offers some potential for understanding the nature of these secondary sources and their use by Archaic populations.

Finally, the model of exchange proposed in this study has proven to be of value to understanding the changing social dynamic during the Late Archaic. It appears to be supported by this case study, but it does rely on one factor that is difficult to measure in prehistoric populations—reproductive success. All of the exchange benefits discussed in this study are ultimately assumed to help individuals gain greater reproductive success. But do they? To address this question we need to work with modern small-scale societies where we can directly measure the benefits and costs involved. It is recommended that research be conducted with living populations to measure the costs associated with participation in exchange networks, the benefits gained in many areas through such participation, and the ultimate reproductive fitness of participants relative to non-participants. Such a study may either support or refute the foundation of this model.

Looking back, it has been a long journey since stepping out of that truck in 1994. As with most journeys, though, this one doesn't lead back home but rather opens more doors to yet more journeys, more destinations, and ultimately onward.

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APPENDIX I

OVERIEW OF SITES USED IN THIS STUDY

Several Archaic and Initial Woodland sites are included in this study, covering an area from Lake Superior to the lower Illinois Valley. The primary sites involved in this study include several Burnt Rollways phase sites from the Northern Highlands, including the Duck Lake site in Michigan, and the Burnt Rollways, Kapitz, Rainbow Dam East, Rainbow Dam West sites in northern Wisconsin. The mortuary contexts at the Late Archaic Riverside site and the Middle Archaic Reigh site greatly contribute to this research. Collections from these sites have been analyzed in detail, and this data forms the core of this dissertation.

Other sites are critical to this research, due to their ability to provide additional context, and to extend observed trends across a broader portion of the midcontinent. These include the Late Archaic sites of Convent Knoll, Mound F^{o}11 at the Morton Mounds site, and the Thiensville site. Published sources were used for Convent Knoll and Morton Mounds, while copper from the Thiensville site was used in the compositional analysis featured in Chapter Eight.

The dissertation emphasizes trends and an analysis of the role of exchange in Late Archaic social change; it does not contain detailed descriptions of each of these sites. To provide that detail, this appendix will discuss each of the major sites used in this study, including its setting, previous research, material culture, and dates. Descriptions of the Burnt Rollways phase sites of Burnt Rollways, Kapitz, Rainbow Dam East, Rainbow Dam West, and Duck Lake, along with those for the Middle Archaic Reigh cemetery, and the Late Archaic Red Ocher associated sites of Riverside, Thiensville, and Convent Knoll are included here. Published sources were used for the remaining sites and the reader is referred to these for additional detail.

Sites of the Burnt Rollways Phase

Burnt Rollways Site

The Burnt Rollways site is the type site for the Late Archaic Burnt Rollways Phase. Excavations were conducted at this site during the late 1960's under the direction of Robert Salzer as part of his dissertation research at Southern Illinois University (Salzer 1969, 1974). Informants initially noted a large number of projectile points and copper artifacts in the vicinity of the Burnt Rollways Dam, operated by the Wisconsin Valley Improvement Corporation.

Burnt Rollways is located in extreme northern Oneida County, Wisconsin, on a high gravel and sand ridge and adjacent bottomland on the north bank of the Eagle River (Figure I.1). Eight test units were excavated on the ridge, and two in the bottomland, revealing a rich deposit of lithics, copper tools, and four grit-tempered ceramic sherds.

Over three thousand pieces of lithic debitage, ninety four lithic tools, and ten copper items were recovered during excavations. Four grit-tempered sherds had been found on the surface, but were not believed to be associated with the buried component, representing instead a small Woodland occupation. Projectile points included corner notched points similar to Preston-notched, along with side notched forms. Other lithic tools include several oval bifaces, scrapers, one drill, and a chert core. Copper artifacts included seven pieces of waste debris, two copper awls with rectangular cross-sections, and a single small copper crescent.

The investigators interpreted the site has having two separate buried aceramic components; the largest associated with the ridge and the other associated with the lower bottomland along the river. Chert was used in the manufacture of over half the lithic tools, while quartz dominated the debitage assemblage. This was interpreted as representing the importation of tools or chert blanks to the site, while utilizing the locally available quartz for on-site tool production.

The copper assemblage and projectile points suggested that the site was associated with a Late Archaic occupation, which had not previously been identified in the area. Salzer (1969; 1974) named this the Burnt Rollways Phase and suggested that it dated between 3000 and 2500 BP based on similarities with the then well researched and dated Riverton culture of the Wabash Valley in Illinois (Winters 1969). Though charcoal was noted, no dates were obtained from this site during Salzer's investigations.

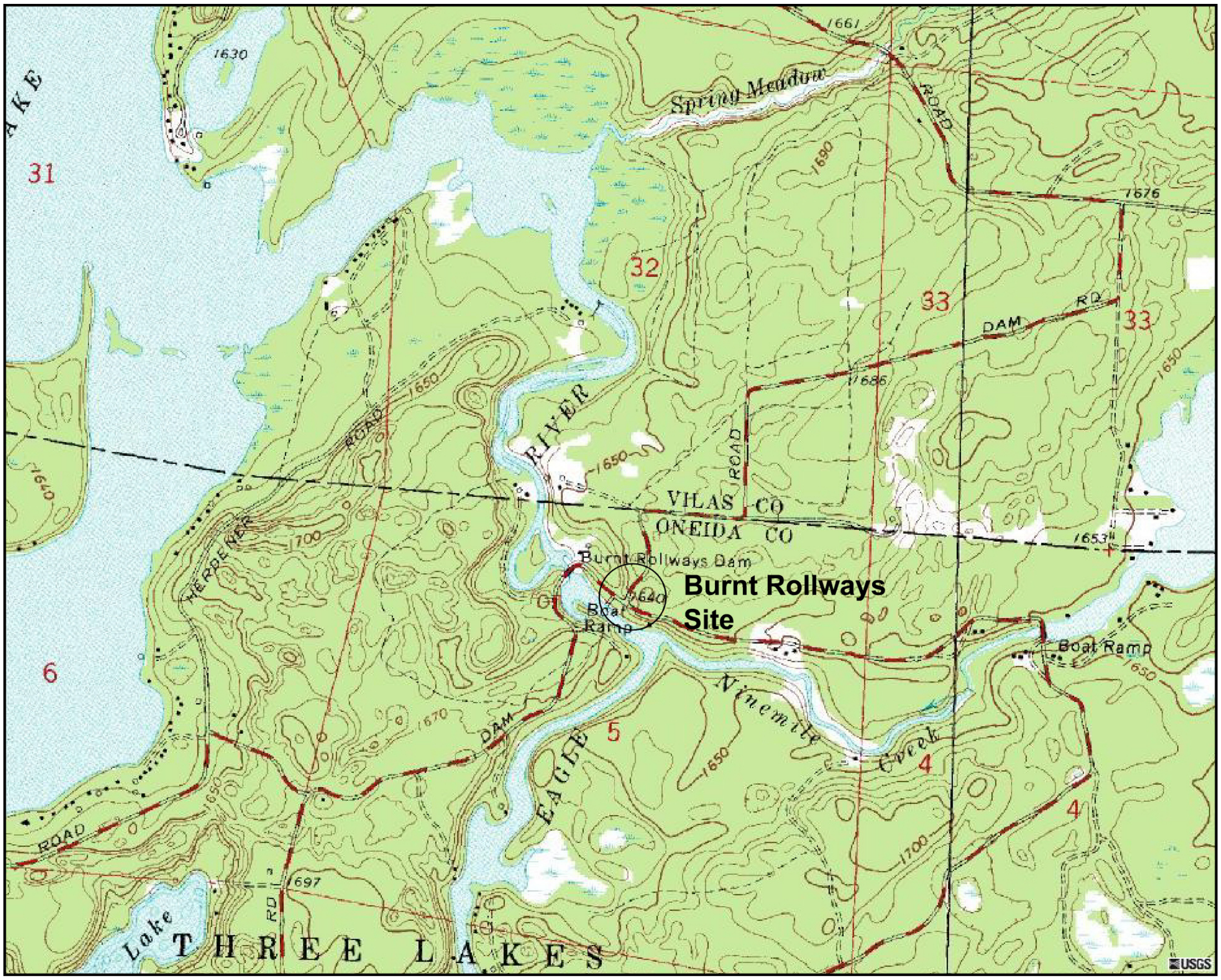

Figure I.1. Location of the Burnt Rollways site on the north bank of the Eagle River in extreme northern Oneida County, Wisconsin.

During the current analysis of the materials from the Burnt Rollways site, several charcoal samples were identified from general level fill associated with this Burnt Rollways component. The first of these was associated with Late Archaic materials in test pit 5, level B. AMS analysis yielded a conventional radiocarbon age of 2280 ± 40 (Beta-232440), which is calibrated using the intcal04 curve (2σ) to 2160-2260 BP and 2300-2350 BP. A second sample was collected from test pit 4, level B. Associations of this sample were less clear, and it is either associated with the Late Archiac Burnt Rollways phase component or a later Nokomis phase Woodland component. AMS analysis yielded a conventional radiocarbon age of 1540 ± 40 BP (Beta-243582), which was calibrated using the intcal04 curve to a 2σ range of 1340 to 1530 BP. Given this late date, it is likely that this sample is associated with the Nokomis component, but that is not demonstrable from an examination of the excavation notes.

The Burnt Rollways collections are curated at the Logan Museum of Anthropology at Beloit College. These materials were loaned to Washington State University for analysis as part of this dissertation research. The final catalog of materials is included in Appendix VI.

Kapitz

The Kapitz site was also brought to the attention of archaeologist by informants identifying cultural material on the surface and in the area of a former gravel quarry. Salzer conducted limited test excavations here in the late 1960's, demonstrating that much of the site had been destroyed by gravel quarrying (Salzer 1969, 1974).

Kapitz is located on a high gravel esker on the west side of Willow River, a tributary of the Wisconsin River, in Oneida County, Wisconsin (Figure I.2). Four five by five foot test units were excavated on this esker. Test pit 2, located at the north end, produced no material and was believed to lie outside the site boundaries. The remaining three units produced a small amount of cultural material, including fifty three pieces of debitage, one broken projectile point, two scrapers, a biface fragment, and four utilized flakes. One copper point was located by collectors prior to excavation, but no other copper artifacts or debris was encountered during excavation.

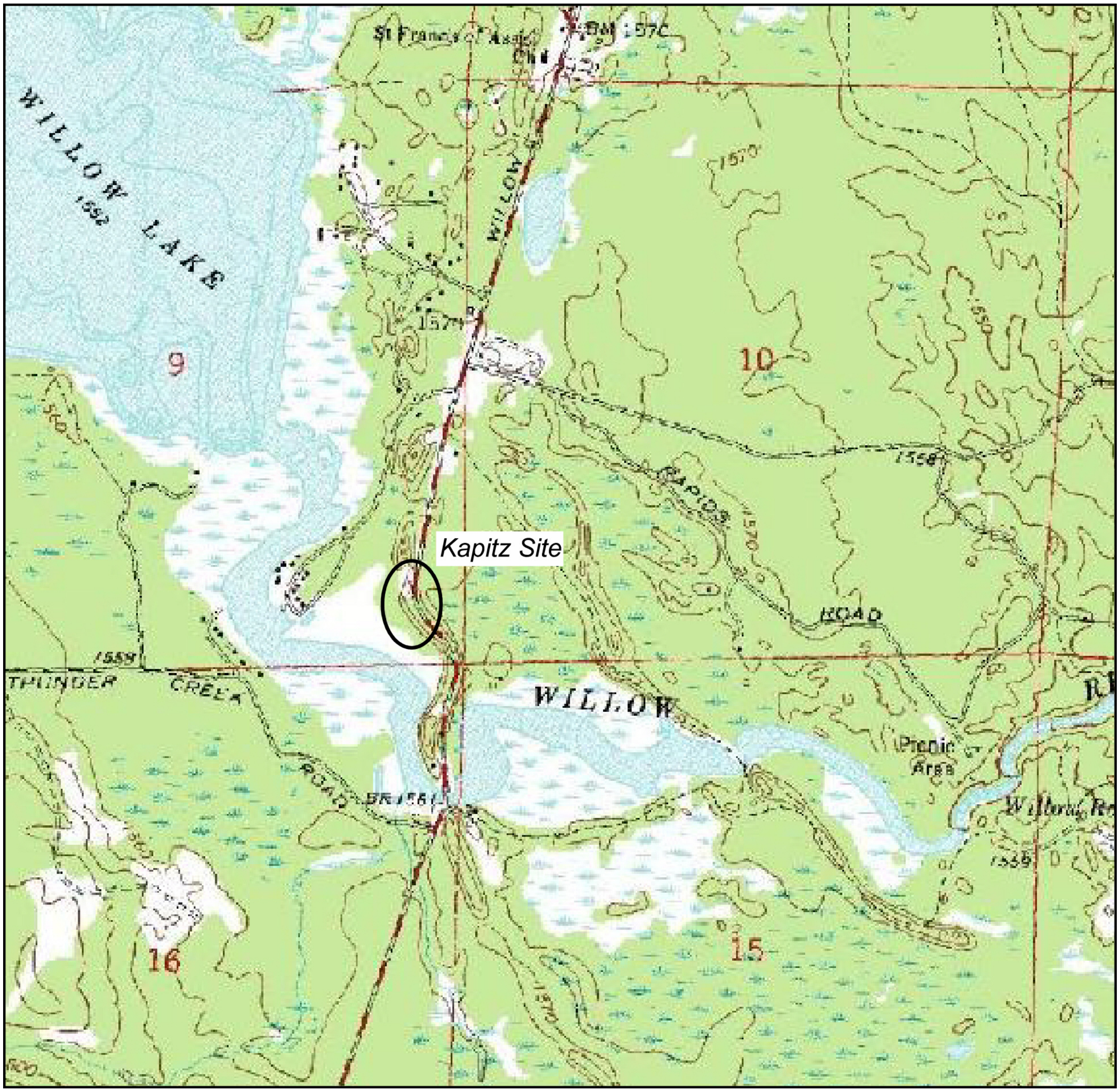

Figure I.2. The location of the Kapitz Site on the north bank of the Willow River in western Oneida County, Wisconsin.

As with the Burnt Rollways site, much of the lithic debitage was locally available quartz, while the few tools were manufactured from mostly non-local materials including quartz, Hixton orthoquartzite, and chert. No dates were obtained during the excavation project, but based on the lack of ceramics, the perceived association of the site with higher water tables of the Willow River, the copper artifact, and the lithic assemblage, Salzer (1969, 1974) assigned it to his new Late Archaic Burnt Rollways phase. During the analysis for this study, charcoal was found in the collections from this site, consisting of general level fill from test pit 1, level B. Field notes showed this to be roughly consistent with the Late Archaic component and the sample was subsequently submitted for dating. AMS analysis produced a conventional radiocarbon age of 170 ± 40 BP (Beta-243583). Calibration of this date using the intcal04 curve yielded two intercepts within the 2σ range, including AD 1650-1890 and AD 1910-1950. Given the very recent age of this sample, it likely represents contamination by modern charcoal perhaps associated with forest fires. Unfortunately, Kapitz remains poorly dated.

The original collections from Kapitz are housed at the Logan Museum of Anthropology at Beloit College. These collections were loaned to Washington State University for purposes of this research.

Rainbow Dam Sites

The Mississippi Valley Archaeology Center conducted test excavations at the Rainbow Dam East and Rainbow Dam West sites on the Rainbow Flowage during 1990 as part of a larger survey and evaluation project in the Wisconsin River headwaters (Moffat 1999; Moffat and Speth 1999). The sites are located on the east and west shores of the narrow channel between Pickeral Lake to the north, and the Rainbow Flowage to the south (Figure I.3). Excavation of both revealed features that were associated with both Archaic and Woodland components; yet it has proven difficult to associated materials found outside of these features with dated components due to the compressed stratigraphy characteristic of sites in the Northern Highlands.

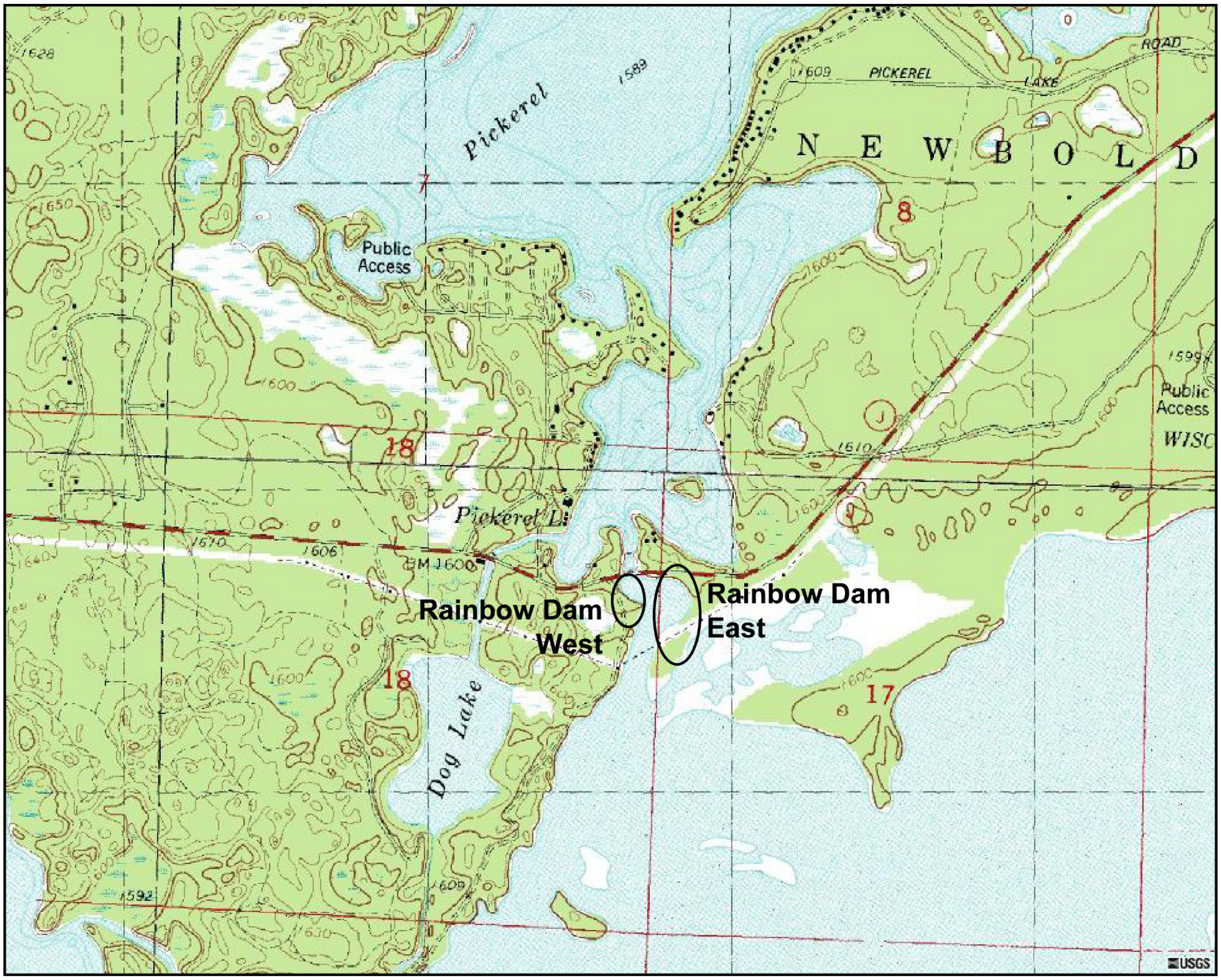

Figure I.3. The Rainbow Dam East and Rainbow Dam West sites on the channel between Pickerel Lake and the Rainbow Flowage. Oneida County, Wisconsin.

Rainbow Dam East: the Rainbow Dam East site is located along the shoreline on the east side of the channel. Seventy six shovel tests were used to identify artifact concentrations which were further explored with six 2 by 2 meter test units. Excavation revealed a Late Archaic component associated with the Burnt Rollways Phase, and an Early to Middle Woodland Nokomis Phase component (Moffat and Speth 1999). Six features were identified, three of which (F3, F4, and F5) were associated with the Late Archaic component as determined by radiocarbon dates and associated materials. Feature 3 was a basin-shaped pit with lithic debitage, a copper awl, copper scrap, and burned bone. A radiocarbon date of 3630 ± 60 BP (Wis-2269) was obtained from a charcoal sample collected from this pit. Using the intcal04 curve, this date was correlated (2σ) to produce four intercepts of 3730-3746 BP (*p*=.011), 3769-3791 B) (*p*=.016), 3825-4096 BP (*p*=.950), and 4118-4145 BP (*p*=.024). Feature 4 was also a shallow basin-shaped pit with lithic debitage, a scraper, and two grinding stones. No dates were obtained from this pit, but its context suggests that it belongs to the Late Archaic component. Feature 5 was a very shallow basin with charcoal, burned rock, and two pieces of copper scrap. Again, the context of this feature suggests assignment to the Late Archaic component. Fill from these features contained blueberry (*Vaccinum* sp.) and blackberry (*Rubus* sp.) seeds, along with highly calcined and degraded mammal and turtle bone. Muskrat and beaver were identified among the mammal bone (Moffat and Speth 1999:139-140).

Over 2000 lithic artifacts, seven copper tools, forty pieces of copper scrap, eleven groundstone tools, and over five hundred ceramic sherds were recovered during excavation. Of these, five hundred and fifty-four lithic artifacts, three grinding stones, two hammerstones, a conical copper point, one copper awl, a copper knife, and twenty-three pieces of copper scrap belong to the Burnt Rollways component (Moffat and Speth 125-140). The lithic assemblage is dominated by locally available quartz, but as with many Burnt Rollways Phase components, chert and other non-local lithics are common among the finished tools. Non-local materials associated with the Late Archaic component include orthoquartzites such as Hixton, small amounts of Knife Lake Siltstone and Gunflint Silica from northeastern Minnesota and adjacent

Ontario, Silurian chert, Prairie du Chien chert, Galena chert, and Knife River Flint (Moffat and Speth 132-133). Projectile points associated with the Late Archaic component include corner-notched and expanding stemmed varieties similar to Preston notched and Monona stemmed. Copper artifact manufacture occurred at the site, as indicated by the large quantity of copper scrap and its association with features such as the Late Archaic pit at Feature 3.

Rainbow Dam West: This site is located along the shoreline on the west side of the channel, immediately west of Rainbow Dam East. Surface collections along the exposed shoreline were followed with ninety-six shovel tests to identify the extent of the deposit. Five 2 by 2 meter test units were then excavated in 10 cm levels across the south half of the site.

Excavation revealed a Late Archaic component and a late Middle to early Late Woodland component, each containing a single feature. The Late Archaic feature, or Feature B, was a basin shaped pit with charcoal, and was associated with a debitage concentration. Charcoal was taken from this feature and used for radiocarbon dating, yielding a determination of 3270 ± 80 BP (Wis-2270). Again using the intcal04 curve, this date is correlated to a 2σ range of 3355-3691 BP.

Six hundred and forty-three lithic artifacts were associated with the Late Archaic component. While this number includes several bifaces, scrapers, and utilized flakes, the only projectile points were found on the surface. These include a corner-notched point reworked into a drill, and a broken corner-notched point, both consistent with the Late Archaic component. Locally available raw materials—notably quartz - comprise the majority of the debitage, while chert is again more common among the tools. Non-local raw materials include Prairie du Chien, Galena, Cochrane, and Silurian cherts, along with orthoquartzites and a small amount of Knife

Lake Siltstone. Materials from more distant sources are rare, but include on flake of Cobden chert from southern Illinois and Knife River Flint from North Dakota (Moffat and Speth 1999:149).

Copper was also associated with the Late Archaic component at Rainbow Dam West, including a fragment of a copper crescent, a copper knife, an awl, and several pieces of scrap. Copper manufacture again seems to have been an activity associated with the Archaic occupation, and appears to have been localized in the northern part of the site.

Faunal and plant remains were obtained from level fill and the Archaic feature. These include mammal and turtle bones. Four of the mammal elements were identified as beaver (*Castor canadensis*). Blueberry seeds (*Vaccinum* sp.) and tamarack cone fragments were associated with the Archaic feature (Moffat and Speth 1999:140).

Collections from the Rainbow Dam East and West sites are housed at the Mississippi Valley Archaeology Center, associated with the University of Wisconsin—LaCrosse. These collections have been loaned to Washington State University for use in this project.

Duck Lake

The Duck Lake site was originally identified by collectors who identified copper and lithic artifacts on the surface of a dirt road running across the site on lands administered by the USDA Forest Service. During the early 1990's these collectors brought the site to the attention of archaeologists with the Ottawa National Forest, who began a multiyear project to map and investigate the site under the direction of Mark A. Hill (Hill 2006, Chapter Six this volume).

Duck Lake is located on the west side of the East Branch of the Ontonagon River, in Ontonagon County, Michigan (Figure I.4). It occupies a sandy glacial outwash plain fifty meters above the floodplain of the deeply entrenched river. While the site is located on a finely sorted sandy glacial outwash plain, more rugged terrain is located to the northeast and south, where terminal moraines with rocky soils are present on the east side of the river. Primary copper deposits outcrop in the Keweenaw Highlands, just 22 kilometers to the northwest. Secondary copper sources are even closer, with copper glacially transported from the highlands and deposited in the terminal moraine immediately north of the site, visible on the map in Figure X.

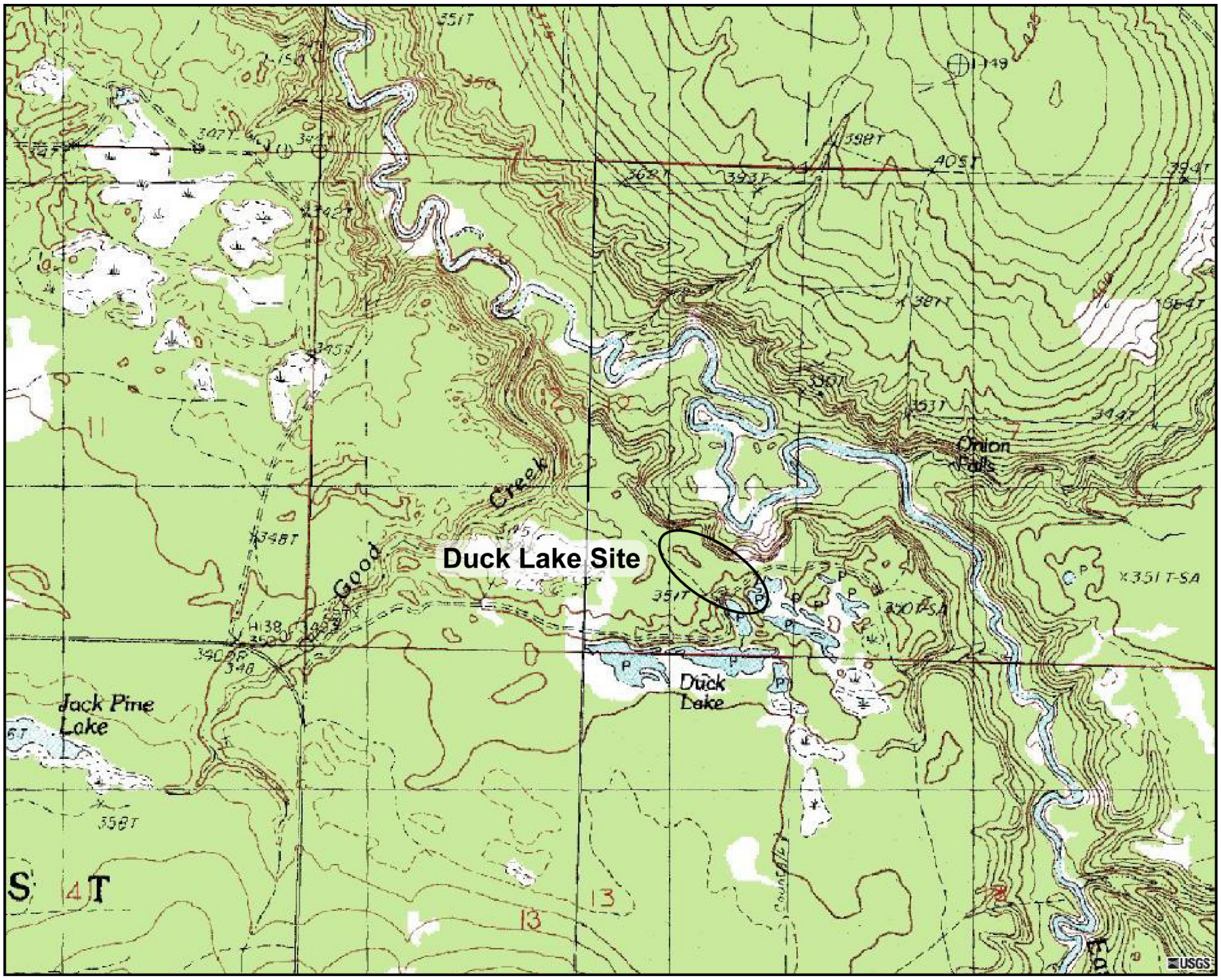

Figure I.4. The Duck Lake site,Ontonagon County, Michigan.

Between 1996 and 1997, twenty-eight square meters were excavated at Duck Lake, mostly in a block excavation on the northern end of the site. Controlled metal detector surveys and systematic shovel testing were also conducted to delimit the extent of the site area and identify activity areas.

Excavation revealed a Late Archaic component with three features. Two of the features, Feature A and Feature B, were unprepared surface hearths associated with lithic tools and debitage, copper tools, and copper waste. Charcoal from Feature A was used to obtain an AMS date of 3420 ± 50 BP (Beta-099777) for this feature, while a charcoal sample from immediately outside Feature B provided an AMS date of 3400 ± 110 (Beta-124454) for this hearth. Combined, these two dates produce a normalized 2σ range of 3561-3832 BP. A worked copper nugget rested upon an anvil stone immediately adjacent to Feature B. A third feature, Feature C, was located midway between the two hearths and consisted of a concentration of charcoal, copper scrap, burned bone, and lithics. Soils from these three features were examined, resulting in the identification of wood charcoal from maple, spruce, red pine, white pine and red oak, along with one seed of bittersweet (*Celastrus scandanens*). One hundred and fifty-five bone fragments were also recovered, but their highly fragmented and burned nature prevented the identification of genus and species. They all appear to represent mammals, and one is raccoon to deer size while a second represents a fisher or martin sized mammal (Hill 2006; Chapter 5 this volume).

Nearly one hundred lithic tools were recovered, including twenty-one formal tools and seventy-six expedient tools. Two projectile points were recovered, including a corner-notched Preston like point in direct association with Feature A and the 3420 ± 50 BP date. A second point fragment represents a straight stemmed point that may suggest continued use of the site into the Early Woodland. Other lithic artifacts include ovate bifaces, drills, and scrapers.

Unlike the Burnt Rollways Phase sites discussed previously, the Duck Lake lithic assemblage is dominated by cherts. The majority of the tools were manufactured from Prairie du Chien and Galena cherts, while Knife River Flint and Onondaga were present as well. Even the debitage was primarily non-local in origin, consisting mostly of Prairie du Chien and Galena cherts. Local materials such as quartz, Hudson Bay Lowland chert, and basalt, comprise less than 13% of the debitage.

Duck Lake features a wide range of copper production activities. Eighty-seven copper items were recovered, including beads, a tanged knife, copper point preforms, and a variety of copper scrap, worked, and unworked nuggets associated with copper production. The association of copper production debris, preforms, and anvil stone associated with a hearth feature dated to 3400 ± 110 clearly establishes the Late Archaic production of copper at this site.

The Duck Lake collections belong to the Ottawa National Forest, but have been loaned to Washington State University for this research. Detailed discussion of this site is presented in Chapter Seven of this volume, and data tables are included in Appendix V.

Middle Archaic and Late Archaic Cemeteries

Reigh

Gravel quarrying on the south shore of Lake Butte des Morts during the 1950s uncovered several burials, which were brought to the attention of the nearby Oshkosh Public Museum. Upon examination of the site, it was recommended that the State Historical Museum conduct salvage excavations prior to resuming gravel operations (Baereis et al. 1954).

This site, known as the Reigh site, is located on a gravel ridge overlooking Lake Butte des Morts in Winnebago County, Wisconsin (Figure I.5). This lake, serves as an important natural crossroads in the region; the Wolf River flows into the lake from its source in the Northern Highlands, the upper Fox River flows into the lake after passing within a short distance of the Wisconsin River near modern Portage Wisconsin, and the lake empties into the much larger Lake Winnebago only a short distance east of the Reigh site. Lake Winnebago, in turn,

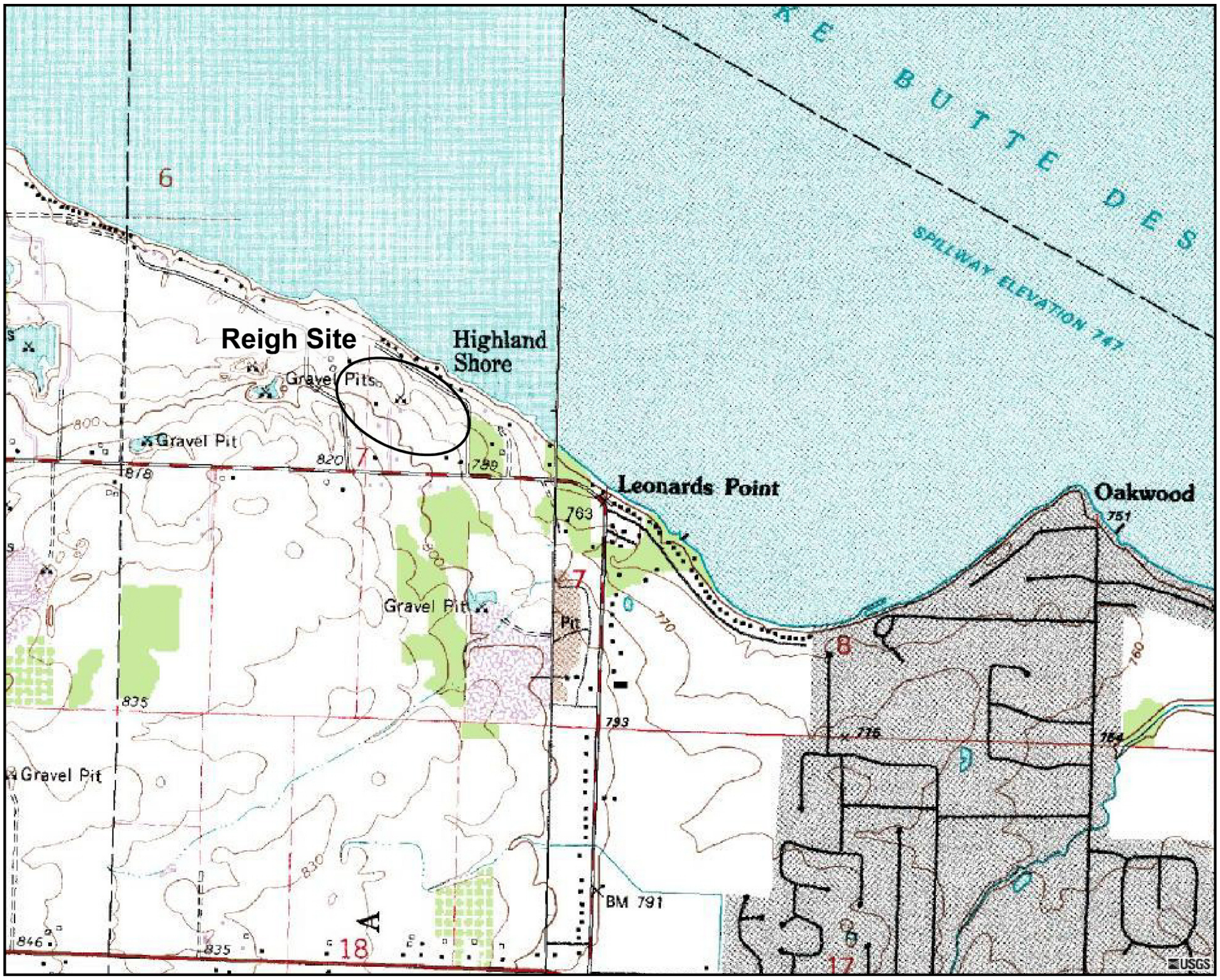

Figure I.5. The location of the Reigh site on the south shore of Lake Butte des Morts, Winnebago County, Wisconsin.

drains down the lower Fox River into Green Bay. Lake Butte des Morts then is at the crossroads connecting the lower Wisconsin River and the Mississippi Valley with the Lake Michigan and Green Bay basin as well as the northern headwaters area through the Wolf River. The concentration of sites demonstrated in Chapter Four of this volume, illustrates the clear importance of this area to populations during the Archaic.

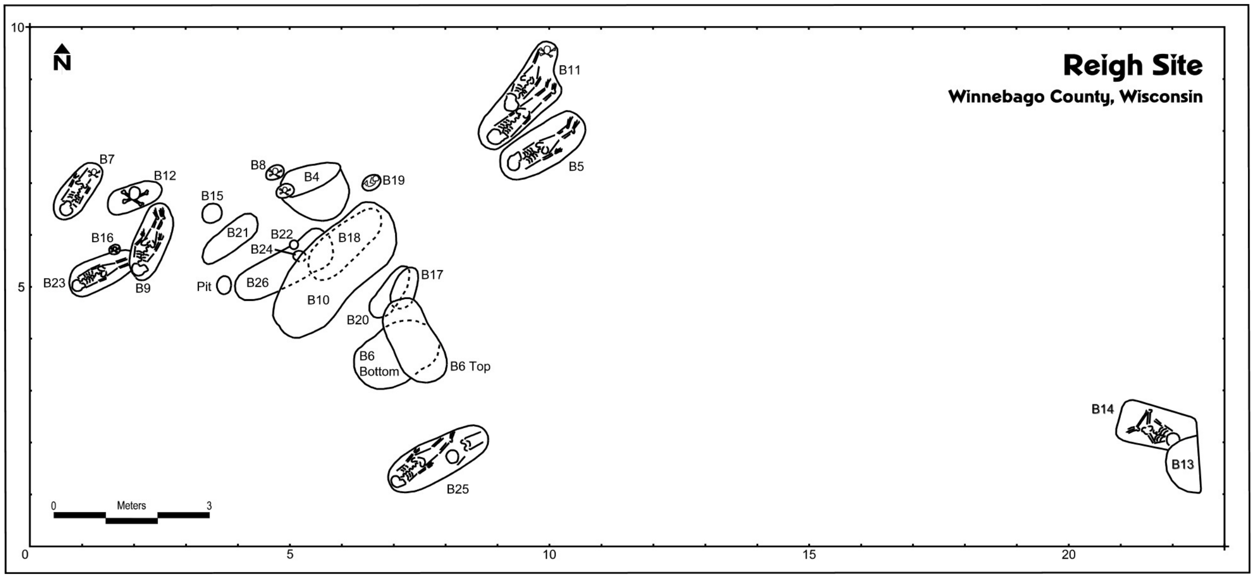

Figure I.6. Burial features at the Middle Archaic Reigh site (after Baerreis et al. 1954:22-23).

Reigh was excavated under the direction of David Baerreis in 1953. Twenty-six burial features were uncovered and excavated, representing a variety of interment types (Figure I.6). Extended, flexed, and secondary bundle burials occurred alongside cremations. The number of individuals represented by these burials has been estimated by several researchers. Baerreis indicated that 43 individuals were removed during excavation. A later analysis by Tse-Min Hsu (1970) concluded that 39 individuals were represented in the collections. During the 1970s the skeletal material was carefully cleaned and recataloged, prior to a detailed analysis by Susan Pfeifer (1977). Pfeiffer concluded that 45 individuals are represented.

Along with the Osceola, Oconto, and Price III sites, Reigh is a key site of the Old Copper Complex (Stoltman 1997:131; Wittry and Ritzenthaler 1954). It is distinguished from the Osceola and Price III sites by its emphasis on primary interments and the use of multiple discrete graves rather than the mass graves that characterize the southwestern sites.

Figure I.7. Reigh site copper "feathers."

Excavation revealed that interment of grave goods with individuals was limited at Reigh. A total of 125 artifacts were associated with the interments. Several types of grave goods are found, many of which are unique to Reigh. Among these are large side notched bifaces (see Figure 5.9), a collection of copper "feathers" which formed a headdress for an adult male (Figure I.7), and a single sandal-sole gorget shown in Figure 5.6 (Baerreis et al. 1954). Other grave goods include bird bone tubes, elk antler axe handles, shell beads, copper beads, conical copper points, and hafted bifaces.

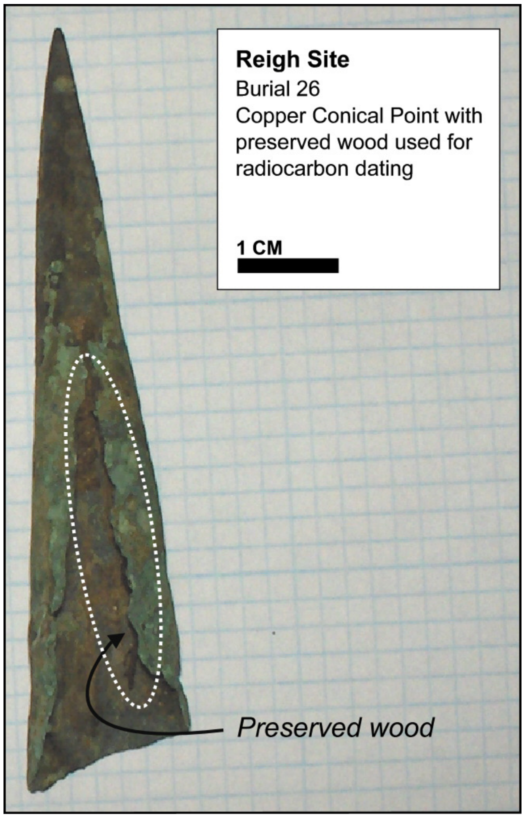

Figure I.8. Conical copper point from Burial 26 at the Reigh site, with preserved wood used for AMS dating.

Baerreis noted that the Reigh site contained elements identified with both the Old Copper complex as well as with Glacial Kame. The Glacial Kame association occurs mostly through the single sandal-sole gorget.

Previous research at Reigh had produced only a single radiocarbon date of 3660 ± 250 BP from Reigh (calibrated using intcal04 to 3390-4800 BP at 2σ). While analyzing copper artifacts during this current study, a small sample of preserved wood was identified adhering to the inside of the socketed portion of the conical copper point recovered from Burial 26 (Figure

I.8). This wood sample was removed and submitted for AMS dating, producing a conventional radiocarbon age of 4490 ± 40 BP (Beta-247459). Calibration of this date using the intcal04 curve produced a 2σ range of 4970-5300 BP. These two dates suggest that Reigh, like the early Middle Archaic cemetery at Oconto and the Late Archaic cemetery at Riverside, was in use for several centuries and that it lies intermediate between the use of Oconto and Riverside. From this, it appears that Reigh represents a middle period in the shifting centers of mortuary and social ritual in the northwestern Lake Michigan basin.

The Reigh collections are housed with the Wisconsin Historical Society. Portions of the collection have been examined at this institution, while several copper items were loaned to Washington State University for chemical composition analysis.

Riverside

Collectors had long been aware of the presence of copper artifacts at what has become known as the Riverside site. Quimby (1957) reported on copper items in the Chicago Natural History Museum that he believed were originally from this site. Yet it was not until the excavations of the University of Michigan in 1956 and 1957, directed by Albert Spaulding, that formal investigations began (Hruska 1967; Papworth 1967). Spalding excavated seven burial features that were later analyzed and published by Papworth (1967) in his doctoral dissertation. In 1961, the Oshkosh Public Museum sponsored additional and more extensive excavations under the direction of Robert Hruska (Hruska 1967). These combined projects ultimately identified over 80 features, representing the burial of a minimum of 76 individuals in 58 burial features (Figure I.9).

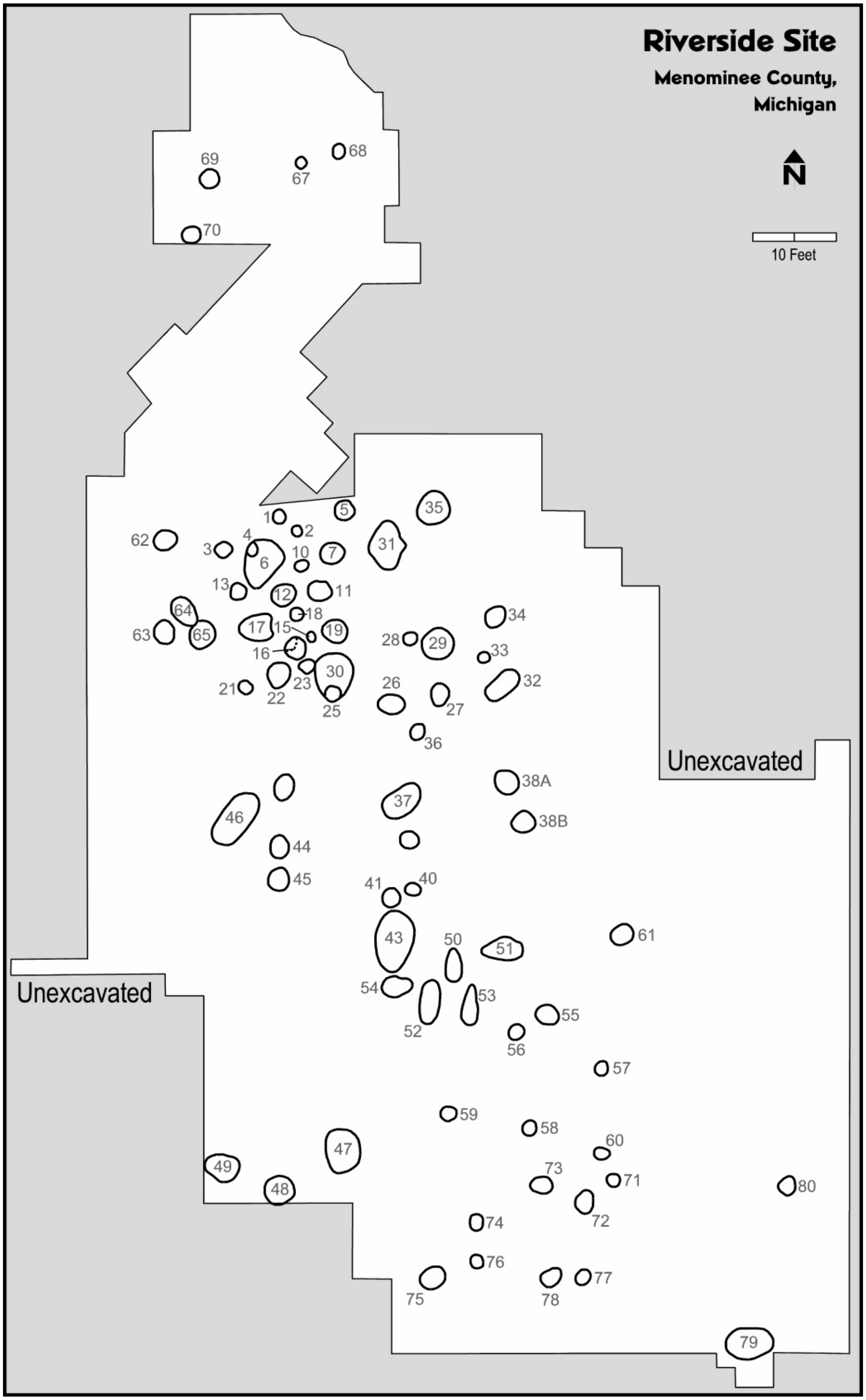

Figure I.9. Excavations and features at the Riverside site.

The site is located on a point extending into the Menominee River approximately three miles upstream from the mouth of that river on the western shore of Green Bay (Figure I.10), within the modern Riverside Cemetery in the town of Menominee, Michigan. Before the damming of the river upstream from the site, this river bend had been the site of series of rapids that were known spawning beds for sturgeon (Goodyear et al. 1982; Hruska 1967). A series of sandy ridges ran generally north to south across the site, many of which were leveled during dam construction. The Archaic burials were located in one of the more prominent sandy ridges adjacent to the river, and are often mistaken as a burial mound though the ridge is a natural feature. Occupational debris and features were reported and recovered, but description of these areas is limited to brief references to the "village" materials.

The University of Michigan and more extensive Oshkosh Public Museum excavations revealed a site similar in some respects to the Reigh site discussed above, but very different in others. Overall similarities include the mortuary practices featuring single primary interments with frequent cremations and secondary burials. As at Reigh, a few individuals are deliberately buried with others. Spaulding's excavations of Feature 6 especially recalls the burials at Reigh with a single adult male in a flexed burial accompanied by copper and lithic projectile points, dog skulls, beaver teeth, bone and antler items (Papworth 1967:162-167). Bone from this feature produced an uncalibrated date of 3040 ± 150 BP (M-658), the earliest known date at the site.

While these characteristics are similar to the Middle Archaic Reigh site, there are significant differences as discussed in this study. In particular, Riverside features far more exotic material items than Reigh, most notably in the large quantities of copper beads (Figure I.11), other copper artifacts such as bifaces of Wyandotte and Burlington chert (Figure I.12) and copper celts (Figure I.13). The second significant difference is in the treatment of women and children after death. At Reigh, children are buried without accompanying grave goods, at Riverside they have more material items than any other age or sex category. This observation was explored in Pleger's 1998 dissertation, as well as this current study.

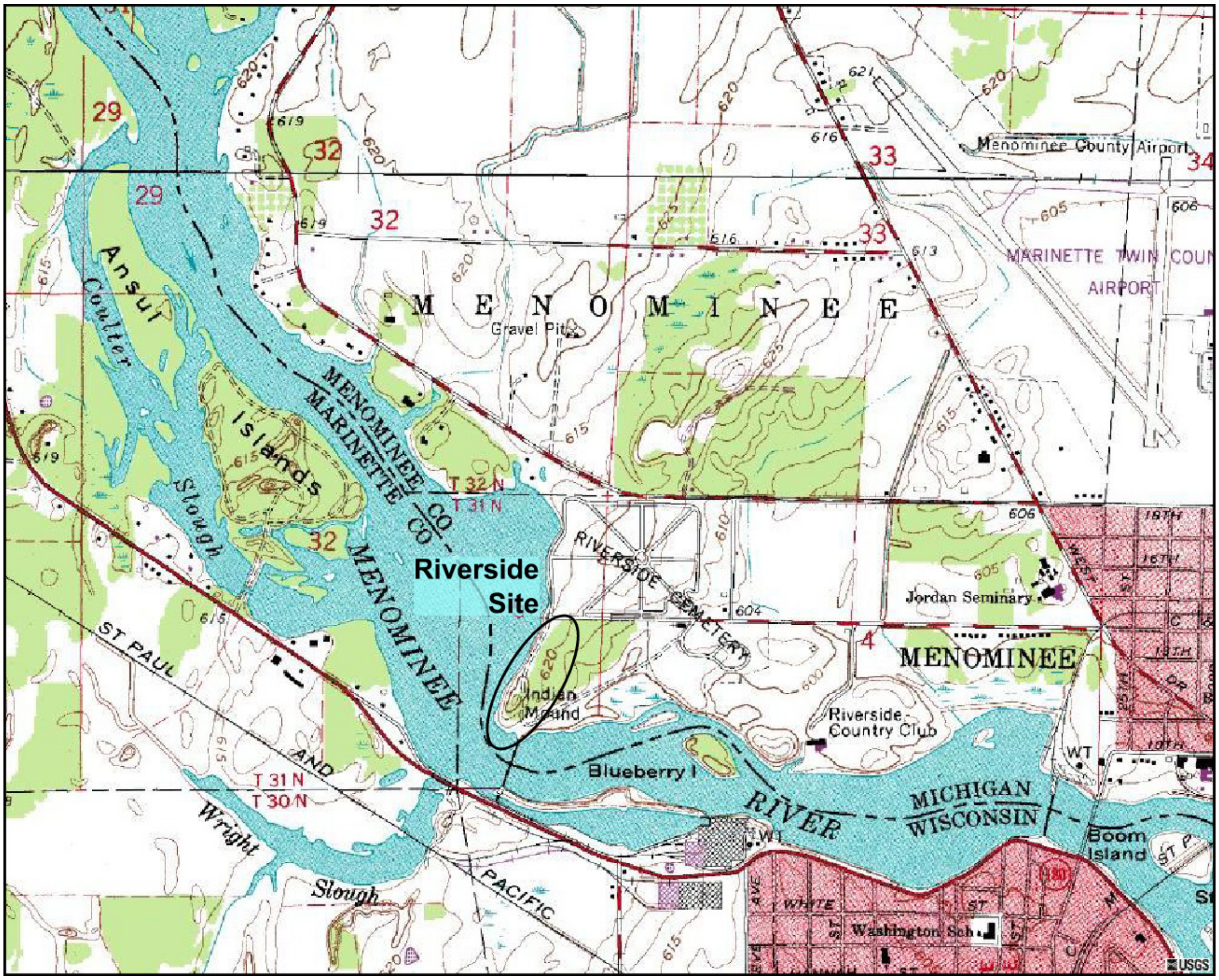

Figure I.10. The Riverside site, Menominee County, Michigan.

Several dates place the use of this site between 3000 and 1900 BP (see Table 4.3). This is an important transitional period in Midcontinental archaeology, from the small-scale societies of the Middle Archaic to the increasing social complexity and interaction of the Early Woodland.

Riverside is contemporary with Adena in the Ohio Valley, and the earlier Middle Woodland Hopewell societies to the south. The later periods at Riverside see the appearance of Early Woodland ceramics, which are found in the "village" deposits. No ceramics were deliberately buried in any of the graves, but during this study a single cord-marked sherd was identified within the fill of Feature 27. Two radiocarbon dates have been produced from charcoal found within this feature, yielding uncalibrated dates of 2850 ± 50 BP (AA19685/WG2411) and 2190 ± 140 BP (M-1717). These dates do not overlap even at 2σ suggesting that two events are being represented within this feature. Given the late introduction of ceramics in the northern Lake Michigan basin, it seems likely that the sherd is associated with the second event dated to 2190 BP.

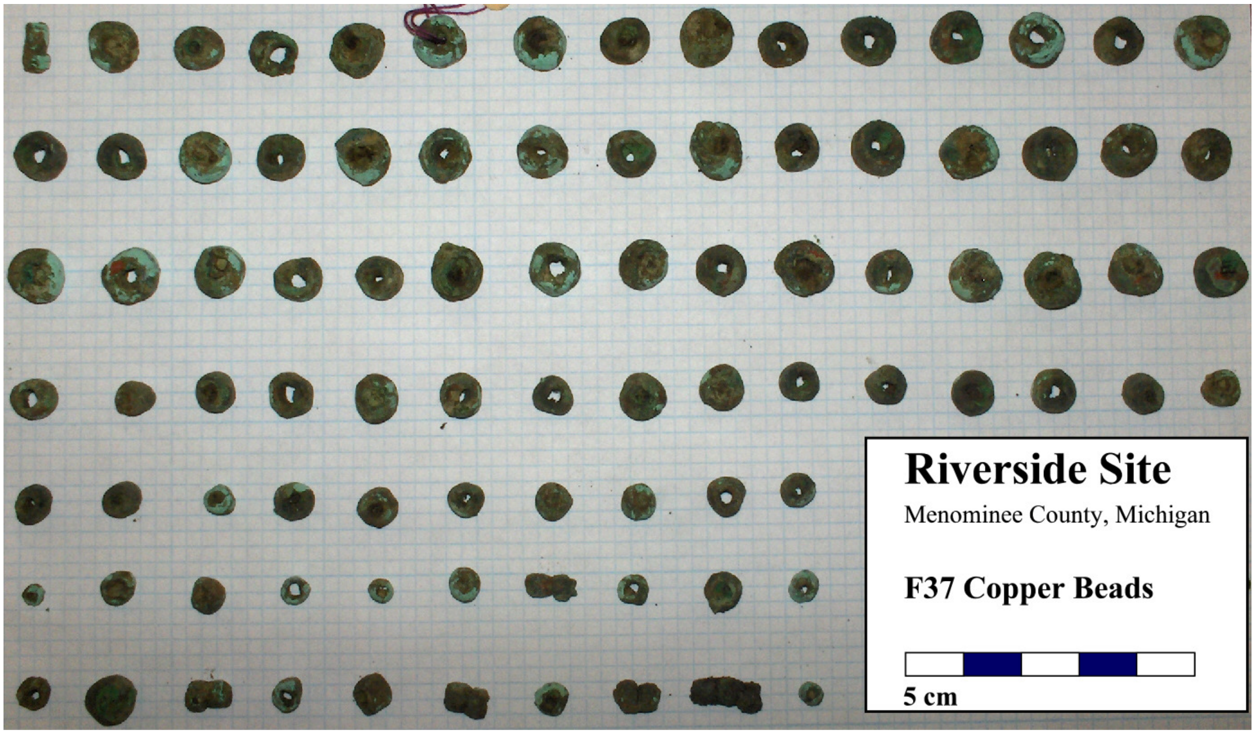

Figure I.11. Riverside site copper beads.

The Riverside collections are, or were, curated in three facilities. The majority of these materials are housed at the Milwaukee Public Museum. The MPM graciously allowed extensive access to these collections, and loaned copper artifacts from these collections to Washington State University, for this study. Collections from the University of Michigan excavations are housed at the Museum of Anthropology at the University of Michigan. During his dissertation research, Thomas Pleger gained access to these collections and his data was subsequently made available for use in this study. The Oshkosh Public Museum was the third repository containing collections from Riverside, but while attempting to access these collections it was learned they had been repatriated to the Menominee Tribe. Again, Thomas Pleger's notes from this collection were made available for use in this study.

Figure I.13. Bifaces interred as grave goods at the Riverside site, including two Adena points (upper left). The Adena point in the upper left corner is Burlington chert, all others are Wyandotte chert.

Figure I.12. Riverside copper celt.

Thiensville (Blume Burial)

Located just north of the Milwaukee River in Ozaukee County, Wisconsin (Figure I.14), the Thiensville site (also known as the Blume Burial) was excavated in 1958 to reveal three burials in a sand ridge (Ritzenthaler and Niehoff 1958; Ritzenthaler and Quimby 1962:258). These burials include a single flexed female and two burials of adult males. Powdered hematite, or Red Ocher, was sprinkled liberally over all three interments. Accompanying these three burials were five turkey-tail bifaces of Wyandotte chert, one large stemmed or side-notched biface of the same material, one tanged biface of Wyandotte, four copper awls, copper and marine shell beads, galena cubes, a three-hole polished-stone gorget, and 55 ovate bifaces of various cherts---one of which has been identified by this research as heat-treated PDC (Figure I.15d).

According to the site form on file with the Wisconsin Historical Society, most of these materials were found in a cache near the pelvis of the single female burial. While the number of known and documented graves is far fewer, Thiensville resembles Riverside in many key aspects, including the large number of Wyandotte bifaces and copper beads, and the association between the lone female and the majority of these exotic goods.

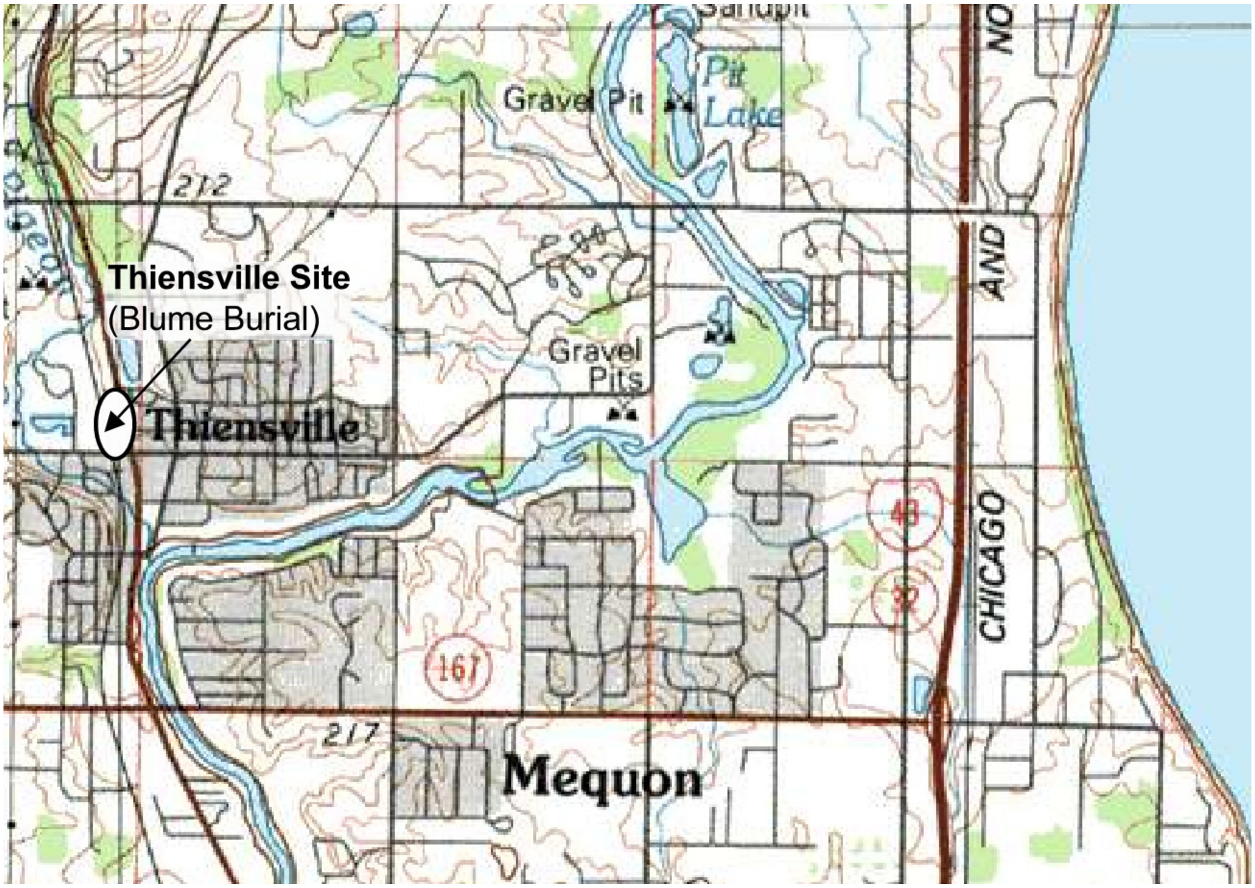

Figure I.14. The Thiensville site, Ozaukee County, Wisconsin.

The Thiensville site remains undated, and access to the collections is limited as many of the artifacts are on display at the Wisconsin Historical Society and are not available for analysis. Due to these two factors, the Theinsville site has largely been excluded from this study. However, several copper beads (Figure I.15b,c) were available for LA-ICPMS analysis and were used to gain a broader understanding of the copper sources used during the Late Archaic to Early Woodland transitional period by societies participating in the Red Ocher system of interaction.

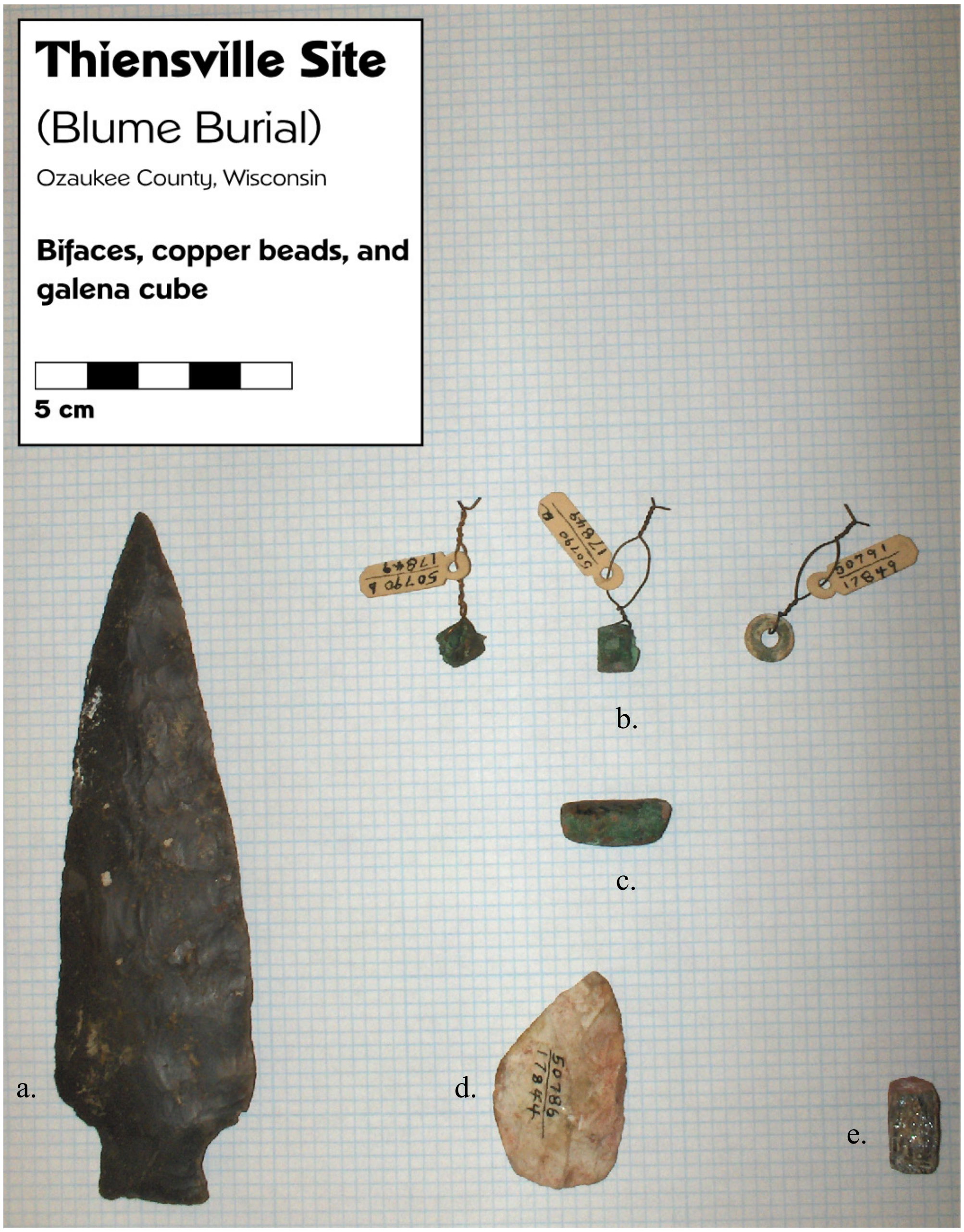

Figure I.15. Thiensville artifacts including a stemmed Wyandotte biface (a), three globular copper beads (b), a tubular copper bead (c), an ovate biface of heat-treated PDC (d), and a galena cube (e).

APPENDIX II

SITE AND POPULATION DATA FOR THE WESTERN GREAT LAKES

Lat	Long	Pop	Sites
43.50	-90.75	1005	0
43.50	-90.50	0	0
43.50	-90.25	2575	2
43.50	-90.00	1826	1
43.50	-89.75	4650	0
43.50	-89.50	2840	1
43.50	-89.25	2099	0
43.50	-89.00	2686	1
43.50	-88.75	5604	0
43.50	-88.50	13882	5
43.50	-88.25	6902	5
43.50	-88.00	7479	5
43.50	-87.75	35067	3
43.50	-87.50	50792	0
43.75	-90.75	13663	11
43.75	-90.50	14043	5
43.75	-90.25	7216	3
43.75	-90.00	11672	4
43.75	-89.75	7421	1
43.75	-89.50	4813	0
43.75	-89.25	8479	2
43.75	-89.00	5583	5
43.75	-88.75	19681	9
43.75	-88.50	8083	6
43.75	-88.25	62727	36
43.75	-88.00	16458	43
43.75	-87.75	22765	14
43.75	-87.50	1361	0
44.00	-91.00	1124	5
44.00	-90.75	3145	11
44.00	-90.50	1990	9
44.00	-90.25	4713	2
44.00	-90.00	3835	2
44.00	-89.75	6440	3
44.00	-89.50	3326	0
44.00	-89.25	7685	1
44.00	-89.00	9689	2
44.00	-88.75	6692	14
44.00	-88.50	87949	19
44.00	-88.25	80477	2
44.00	-88.00	13148	14
44.00	-87.75	13213	5
44.00	-87.50	56054	10
44.25	-91.00	2478	1
44.25	-90.75	11530	8
44.25	-90.50	1562	5
44.25	-90.25	1331	0
44.25	-90.00	2432	0
44.25	-89.75	46416	2
44.25	-89.50	18730	1
44.25	-89.25	7292	2
44.25	-89.00	19697	1
44.25	-88.75	13916	3
44.25	-88.50	25777	14
44.25	-88.25	121964	8
44.25	-88.00	79122	3
44.25	-87.75	36378	1
44.25	-87.50	10773	6
44.50	-91.00	529	0
44.50	-90.75	1103	1
44.50	-90.50	8754	3
44.50	-90.25	8320	2
44.50	-90.00	27817	1
44.50	-89.75	3352	4
44.50	-89.50	35727	7
44.50	-89.25	8614	3
44.50	-89.00	5434	1
44.50	-88.75	11568	0
44.50	-88.50	6500	4
44.50	-88.25	10871	1
44.50	-88.00	33684	13
44.50	-87.75	109135	9
44.50	-87.50	9487	1
44.50	-87.25	6746	0
44.75	-90.75	3011	0
44.75	-90.50	7357	0
44.75	-90.25	11656	0
44.75	-90.00	7663	0
44.75	-89.75	11044	0
44.75	-89.50	86978	5
44.75	-89.25	6546	0
44.75	-89.00	5135	0
44.75	-88.75	4746	0
44.75	-88.50	18060	5
44.75	-88.25	8707	2
44.75	-88.00	10236	8
44.75	-87.75	8238	5
44.75	-87.50	1197	4
44.75	-87.25	16446	1
44.75	-87.00	738	0
45.00	-90.75	1221	0
45.00	-90.50	1684	0
45.00	-90.25	12145	0
45.00	-90.00	4281	0

Lat	Long	Pop	Sites
45.00	-89.75	2623	0
45.00	-89.50	21415	0
45.00	-89.25	1473	0
45.00	-89.00	14503	0
45.00	-88.75	1916	0
45.00	-88.50	5667	0
45.00	-88.25	3284	2
45.00	-88.00	5967	1
45.00	-87.75	4784	1
45.00	-87.50	31995	6
45.00	-87.25	1313	2
45.00	-87.00	2242	0
45.25	-90.75	598	0
45.25	-90.50	689	0
45.25	-90.25	2088	0
45.25	-90.00	2325	0
45.25	-89.75	773	0
45.25	-89.50	8096	2
45.25	-89.25	2011	0
45.25	-89.00	2006	0
45.25	-88.75	2819	0
45.25	-88.50	2227	1
45.25	-88.25	1404	0
45.25	-88.00	3666	0
45.25	-87.75	4029	2
45.25	-87.50	5625	1
45.25	-87.25	276	0
45.25	-87.00	1858	0
45.25	-86.76	660	0
45.50	-90.50	1667	0
45.50	-90.25	4904	0
45.50	-90.00	724	0
45.50	-89.75	944	0
45.50	-89.50	6562	5
45.50	-89.25	15702	0
45.50	-89.00	1442	0
45.50	-88.75	3580	1
45.50	-88.50	1983	1
45.50	-88.25	1283	0
45.50	-88.00	1303	0
45.50	-87.75	2957	2
45.50	-87.50	3147	0
45.50	-87.25	2059	0
45.50	-87.00	15381	0
45.75	-90.50	1854	1
45.75	-90.25	3462	0
45.75	-90.00	989	0
45.75	-89.75	4650	1
45.75	-89.50	12421	1
45.75	-89.25	6075	5
45.75	-89.00	6495	8
45.75	-88.75	1122	0
45.75	-88.50	712	1
45.75	-88.25	2850	0
45.75	-88.00	23118	0
45.75	-87.75	6511	0
45.75	-87.50	3040	0
45.75	-87.25	2452	0
45.75	-87.00	15501	0
45.75	-86.75	1109	0
45.75	-86.50	1877	0
46.00	-90.75	150	0
46.00	-90.50	1801	0
46.00	-90.25	920	0
46.00	-90.00	2068	0
46.00	-89.75	1100	0
46.00	-89.50	1471	2
46.00	-89.25	2505	0
46.00	-89.00	2822	0
46.00	-88.75	2833	1
46.00	-88.50	5743	0
46.00	-88.25	4379	0
46.00	-88.00	1412	0
46.00	-87.75	0	0
46.00	-87.50	67	0
46.00	-87.25	451	1
46.00	-87.00	808	0
46.00	-86.75	1877	0
46.25	-90.75	1254	0
46.25	-90.50	2121	0
46.25	-90.25	1022	0
46.25	-90.00	11809	0
46.25	-89.75	3355	0
46.25	-89.50	1051	1
46.25	-89.25	0	0
46.25	-89.00	603	0
46.25	-88.75	0	0
46.25	-88.50	0	0
46.25	-88.25	352	1
46.25	-88.00	1106	0
46.25	-87.75	3093	0
46.25	-87.50	16480	0
46.25	-87.25	11680	2
46.25	-87.00	8055	0

Lat	Long	Pop	Sites
46.50	-90.75	9260	0
46.50	-90.50	1526	0
46.50	-90.25	350	0
46.50	-90.00	2330	0
46.50	-89.75	364	0
46.50	-89.50	1441	0
46.50	-89.25	716	0
46.50	-89.00	1157	3
46.50	-88.75	914	0
46.50	-88.50	4111	0
46.50	-88.25	3926	0
46.50	-88.00	514	0
46.50	-87.75	674	1
46.50	-87.50	9515	2
46.50	-87.25	21673	0
46.75	-90.50	246	0
46.75	-89.25	1769	0
46.75	-89.00	3824	0
46.75	-88.75	246	0
46.75	-88.50	3156	1
46.75	-88.25	1285	0
46.75	-88.00	482	0
46.75	-87.75	724	0
47.00	-88.75	1268	0
47.00	-88.50	18608	1
47.00	-88.25	10822	5
47.25	-88.75	281	0
47.25	-88.50	0	0
47.25	-88.25	8943	0
47.25	-88.00	60	0
47.25	-87.75	172	1
			461

Mean	2.109589
SD	4.824141

APPENDIX III

RIVERSIDE CATALOG

(Features Only)

Riverside Feature Catalog

Acc. No.	Cat. No		Item	Count	Material	L	W	Th	Wt (g)	F.	Location*
21523	55873		Flake shatter	1	Basalt				0.2	3	MPM
21523	55852	b	copper beads	56	copper				1.4	3	MPM
	R381		copper beads	51	copper				103.0	3	OPM
21523	55872		Broken bifaces	21	Wyandotte Chert				32.0	3	MPM
21523	55844	a	Stone fragments	1	stone	65.0	50.0			4	MPM
21523	55844	b	Stone fragments	1	stone	49.0	34.0			4	MPM
21523	55881		copper fragment	1						9	MPM
21523	55763	b	copper beads	83	copper				68.8	13	MPM
21523	55763	c	copper celt	1	copper	69.9	34.9	9.6	96.0	13	MPM
21523	55843	a	Copper tubular beads	332	copper				21.3	17	MPM
21523	55901		scraper	1	Galena	26.0	14.4	3.5	1.0	17	MPM
21523	55898		Limonite	1	limonite	130.0	88.0			17	MPM
21523	55843	b	scraper	1	Wyandotte Chert	19.6	15.7	3.6	1.4	17	MPM
21523	55843	c	scraper	1	Wyandotte Chert	15.7	17.3	4.9	0.9	17	MPM
21523	55896	R388	Ace of Spades Point	1	copper	66.6	25.5	4.4	19.9	21	MPM
21523	55896	R389	Ace of Spades Point	1	copper	67.7	30.8	5.4	27.1	21	MPM
21523	55896	R391	Ace of Spades Point	1	copper	67.7	27.8	4.7	22.1	21	MPM
21523	55896	R394	Ace of Spades Point	1	copper	70.7	28.8	4.6	21.5	21	MPM
21523	55894	R390	Copper awl	1	copper	83.6	5.8	4.0	8.4	21	MPM
21523	55894	R393	Copper awl	1	copper	33.0	3.9	3.8	1.4	21	MPM
21523	55895	R392	Copper crescent	1	copper	71.6	8.6	2.1	6.3	21	MPM
21523	55895	R395	Copper crescent	1	copper	113.7	12.2	3.9	29.0	21	MPM
21523	55891	a	Biface frag	1	Galena	15.4	11.3	5.1	0.7	21	MPM
21523	55865		copper awl	1	copper	300.0	10.0			27	MPM
	R37		Copper awl	1	copper					27	OPM
21523	55867		unhafted biface	1	Galena	51.4	26.9	8.9	11.4	27	MPM
21523	55870	a	shell bead	1	saltwater shell	18.0	13.0			27	MPM
21523	55870	b	shell bead	1	saltwater shell	10.0	10.0			27	MPM
21523	55868		groundstone	1	unid	58.0	27.0			27	MPM
21523	55866	R27	biface	1	Wyandotte Chert	152.3	39.2	11.0		27	MPM
21523	55866	R28	biface	1	Wyandotte Chert	144.4	36.2	10.4		27	MPM

Riverside Feature Catalog

Acc. No.	Cat. No		Item	Count	Material	L	W	Th	Wt (g)	F.	Location*
21523	55866	R29	biface	1	Wyandotte Chert	135.4	32.9	9.9		27	MPM
21523	55866	R30	biface	1	Wyandotte Chert	138.2	33.9	12.5		27	MPM
21523	55866	R31	biface	1	Wyandotte Chert	149.8	38.8	13.4		27	MPM
21523	55866	R32	biface	1	Wyandotte Chert	132.4	34.9	10.0		27	MPM
21523	55866	R33	biface	1	Wyandotte Chert					27	MPM
21523	55866	R34	biface	1	Wyandotte Chert	138.2	36.0	9.9		27	MPM
21523	55870	c	hafted biface fragment	1	Wyandotte Chert	9.6	6.9	3.2	0.2	27	MPM
21523	55723	b1	copper bead	1	copper	5.1	6.4		0.7	29	MPM
21523	55723	b2	copper bead	1	copper	4.9	6.3	2.7	0.4	29	MPM
21523	55723	b3	copper bead	1	copper	4.5	6.7		0.4	29	MPM
21523	55723	b4	copper bead	1	copper	5.1	6.4		0.5	29	MPM
21523	55723	b5	copper bead	1	copper	5.2	6.7		0.4	29	MPM
21523	55723	b6	copper bead	1	copper	4.7	6.7	2.0	0.4	29	MPM
21523	55723	b7	copper bead	1	copper	3.9	6.5		0.3	29	MPM
21523	55723	b8	copper bead	1	copper	6.7	8.1			29	MPM
21523	55723	b9	copper bead	1	copper	6.4	9.1			29	MPM
21523	55723	b10	copper bead	1	copper	7.0	9.1			29	MPM
			copper beads	200	copper				200.0	29	OPM
21523	55725	R	Biface	1	Wyandotte Chert	155.8	39.0	11.8	64.3	29	MPM
21523	55725	R38	Biface	1	Wyandotte Chert	128.8	43.5	8.6	51.8	29	MPM
21523	55725	R39	Biface	1	Wyandotte Chert	129.6	38.0	9.8	47.1	29	MPM
21523	55725	R40	Biface	1	Wyandotte Chert	130.5	44.1	10.6	59.8	29	MPM
21523	55725	R41	Biface	1	Wyandotte Chert	175.9	42.7	11.9	86.1	29	MPM
21523	55725	R42	Biface	1	Wyandotte Chert	177.9	42.1	10.2	76.4	29	MPM
21523	55725	R43	Biface	1	Wyandotte Chert	161.2	49.9	11.6	94.6	29	MPM
21523	55725	R44	Biface	1	Wyandotte Chert	124.8	45.0	8.4	47.3	29	MPM
21523	55725	R45	Biface	1	Wyandotte Chert	123.4	42.2	10.6	51.9	29	MPM
21523	55725	R46	Biface	1	Wyandotte Chert	151.6	43.4	11.4	74.7	29	MPM
21523	55725	R47	Biface	1	Wyandotte Chert	154.2	47.8	10.9	81.4	29	MPM
21523	55725	R48	Biface	1	Wyandotte Chert	143.5	41.7	11.6	64.8	29	MPM
21523	55725	R49	Biface	1	Wyandotte Chert	130.7	41.8	10.4	53.0	29	MPM

Riverside Feature Catalog

Acc. No.	Cat. No		Item	Count	Material	L	W	Th	Wt (g)	F.	Location[*]
21523	55725	R50	Biface	1	Wyandotte Chert	161.3	45.1	11.5	79.4	29	MPM
21523	55725	R51	Biface	1	Wyandotte Chert	140.7	41.9	9.3	58.8	29	MPM
21523	55725	R52	Biface	1	Wyandotte Chert	176.7	47.2	11.3	92.6	29	MPM
21523	55725	R52	Biface	1	Wyandotte Chert	134.1	41.8	9.0	52.4	29	MPM
21523	55725	R53	Biface	1	Wyandotte Chert	170.4	42.9	9.4	67.1	29	MPM
21523	55725	R54	Biface	1	Wyandotte Chert	147.0	40.9	10.0	59.2	29	MPM
21523	55725	R55	Biface	1	Wyandotte Chert	153.4	38.5	9.4	54.9	29	MPM
21523	55725	R56	Biface	1	Wyandotte Chert	183.8	45.8	10.6	91.9	29	MPM
21523	55725	R58	Biface	1	Wyandotte Chert	129.2	44.2	10.7	55.9	29	MPM
21523	55725	R59	Biface	1	Wyandotte Chert	147.5	39.8	9.0	53.5	29	MPM
21523	55725	R60	Biface	1	Wyandotte Chert	169.2	43.1	10.6	78.0	29	MPM
21523	55725	R63	Biface	1	Wyandotte Chert	136.4	39.9	9.8	54.7	29	MPM
21523	55725	R64	Biface	1	Wyandotte Chert	129.9	48.0	9.4	59.7	29	MPM
21523	55725	R65	Biface	1	Wyandotte Chert	138.9	39.9	10.8	56.2	29	MPM
21523	55725	R66	Biface	1	Wyandotte Chert	137.6	38.6	9.0	53.8	29	MPM
21523	55725	R67	Biface	1	Wyandotte Chert	149.2	40.1	10.1	59.7	29	MPM
21523	55725	R68	Biface	1	Wyandotte Chert	176.2	46.4	10.4	86.4	29	MPM
21523	55725	R69	Biface	1	Wyandotte Chert	147.9	42.5	9.8	62.9	29	MPM
21523	55725	R70	Biface	1	Wyandotte Chert	182.8	40.4	11.4	84.4	29	MPM
21523	55725	R71	Biface	1	Wyandotte Chert	126.7	42.6	9.8	50.2	29	MPM
21523	55725	R72	Biface	1	Wyandotte Chert	152.2	43.2	12.1	78.1	29	MPM
21523	55725	R73	Biface	1	Wyandotte Chert	131.5	43.4	10.1	54.3	29	MPM
21523	55725	R74	Biface	1	Wyandotte Chert	173.5	40.7	11.7	79.2	29	MPM
21523	55725	R75	Biface	1	Wyandotte Chert	148.6	37.5	10.0	52.7	29	MPM
21523	55725	R76	Biface	1	Wyandotte Chert	124.6	39.5	9.6	47.8	29	MPM
21523	55725	R77	Biface	1	Wyandotte Chert	154.5	40.8	10.5	63.5	29	MPM
21523	55725	R78	Biface	1	Wyandotte Chert	164.7	40.0	10.5	68.0	29	MPM
21523	55725	R81	Biface	1	Wyandotte Chert	122.7	40.6	10.6	49.4	29	MPM
		R42	biface	1	Wyandotte Chert	155.0	42.0	11.0	80.0	29	OPM
		R43	biface	1	Wyandotte Chert	155.0	40.0	10.0	80.0	29	OPM

Riverside Feature Catalog

Acc. No.	Cat. No		Item	Count	Material	L	W	Th	Wt (g)	F.	Location*
21523	55731		Burned and Broken bifaces	31	Wyandotte Chert				112.7	29	MPM
21523	55841		Biface?	1	basalt	44.8	21.4	8.9	7.1	30	MPM
21523	55815	R1	Biface	1	Wyandotte Chert	99.5	33.8	9.4	29.0	30	MPM
21523	55815	R10	Biface	1	Wyandotte Chert	96.9	33.7	8.5	30.0	30	MPM
21523	55815	R11	Biface	1	Wyandotte Chert	87.9	33.1	8.5	25.0	30	MPM
21523	55815	R12	Biface	1	Wyandotte Chert	95.2	36.1	11.5	30.0	30	MPM
21523	55815	R13	Biface	1	Wyandotte Chert	98.6	33.9	9.5	31.0	30	MPM
21523	55815	R2	Biface	1	Wyandotte Chert	95.3	31.9	7.3	25.0	30	MPM
21523	55815	R3	Biface	1	Wyandotte Chert	101.2	31.1	8.5	26.0	30	MPM
21523	55815	R4	Biface	1	Wyandotte Chert	94.9	34.8	8.9	28.0	30	MPM
21523	55815	R5	Biface	1	Wyandotte Chert	89.1	36.8	9.8	29.0	30	MPM
21523	55815	R6	Biface	1	Wyandotte Chert	90.0	32.6	9.0	25.0	30	MPM
21523	55815	R7	Biface	1	Wyandotte Chert	97.5	33.6	8.6	28.0	30	MPM
21523	55815	R8	Biface	1	Wyandotte Chert	99.3	33.1	8.9	29.0	30	MPM
21523	55815	R9	Biface	1	Wyandotte Chert	91.3	32.2	8.9	29.0	30	MPM
21523	55734	R14	Stemmed Biface	1	Burlington	178.1	36.0	9.0	56.0	31	MPM
21523	55734	R12	Biface	1	Wyandotte Chert	126.1	38.0	12.7		31	MPM
21523	55734	R15	Biface	1	Wyandotte Chert	135.9	38.0	8.6	45.0	31	MPM
21523	55734	R16	Biface	1	Wyandotte Chert	118.2	34.4	9.7	42.0	31	MPM
21523	55734	R18	Biface	1	Wyandotte Chert	122.6	37.8	9.1	46.0	31	MPM
21523	55734	R19	Biface	1	Wyandotte Chert	124.6	36.3	9.4	46.0	31	MPM
21523	55734	R20	Biface	1	Wyandotte Chert	116.3	33.8	9.3	39.0	31	MPM
21523	55734	R21	Biface	1	Wyandotte Chert	118.7	35.0	9.2	41.0	31	MPM
21523	55734	R22	Biface	1	Wyandotte Chert	118.9	35.5	9.6	42.0	31	MPM
21523	55734	R23	Biface	1	Wyandotte Chert	123.4	34.2	10.8	42.0	31	MPM
21523	55734	R24	Biface	1	Wyandotte Chert	118.7	31.4	10.3	39.0	31	MPM
21523	55734	R25	Biface	1	Wyandotte Chert	119.9	37.8	9.8	43.0	31	MPM
21523	55734	R26	Biface	1	Wyandotte Chert	120.8	38.7	9.2	47.0	31	MPM
21523	55904	R406	Ace of Spades Point	1	copper	54.0	19.0	4.0	14.0	32	OPM
21523	55905	R406	Copper crescent	1	copper	114.0	20.0	4.0	35.0	32	OPM

Riverside Feature Catalog

Acc. No.	Cat. No		Item	Count	Material	L	W	Th	Wt (g)	F.	Location*
21523	55848	R412	Projectile point	1	grey quartzite	63.9	23.6	13.2	16.9	35	MPM
21523	55848	R411	Biface	1	Heat Treated PDC	50.8	27.6	8.4	10.4	35	MPM
21523	55849	R417	Hematite	1	hematite	43.1	21.2	14.7	20.6	35	MPM
21523	55930	R421	Ocher	1	hematite	21.9	24.5	6.4	3.7	35	MPM
21523	55930	R422	Ocher	1	hematite	26.5	22.0	5.5	3.5	35	MPM
21523	55848	R410	Hafted biface	1	PDC	41.2	23.2	0.9	8.6	35	MPM
21523	55848	R409	Projectile point	1	Silurian	40.3	24.6	9.4	8.0	35	MPM
21523	55845		stone game ball	1	stone					36	MPM
21523	55920	R96	Biface	1	basalt	20.2	37.6	10.8	8.4	37	MPM
	R90		Adena point	1	Burlington	187.0	53.0	7.0	78.0	37	OPM
21523	55912		copper beads	108	copper				98.5	37	MPM
21523	55918	R92	Copper celt	1	copper	100.0	38.0			37	MPM
21523	55920	R99	Biface frag	1	Galena	27.3	17.4	10.6	4.3	37	MPM
21523	55920	R98	projectile point frag	1	Silurian I	31.6	28.3	9.1	7.2	37	MPM
	R89		Adena point	1	unid	167.0	50.0	10.0	92.0	37	OPM
21523	55920	R97	biface	1	unid	35.6	26.5	8.6	7.7	37	MPM
	R91		Biface	1	unid	226.0	62.0	10.0	163.0	37	OPM
	R84		Biface	1	Wyandotte Chert	150.0	40.0	10.0	66.0	37	OPM
	R83		Biface	1	Wyandotte Chert	150.0	39.0	9.0	58.0	37	OPM
	R85		Biface	1	Wyandotte Chert	146.0	42.0	10.0	67.0	37	OPM
	R86		Biface	1	Wyandotte Chert	145.0	40.0	11.0	64.0	37	OPM
	R88		Biface	1	Wyandotte Chert	172.0	40.0	13.0	87.0	37	OPM
	R87		Biface	1	Wyandotte Chert	150.0	42.0	10.0	69.0	37	OPM
21523	55854	a	Biface frag	1	Galena	18.3	20.0	7.0	2.3	41	MPM
21523	55854	b	Biface frag	1	Galena	15.4	7.3	4.4	0.3	41	MPM
21523	55775	R1015	hafted biface	1	unid	59.2	26.4	6.3	9.0	41	MPM
21523	55775	R1014	projectile point	1	unid	54.5	23.8	8.4	8.1	41	MPM
21523	55777		Copper tubular bead	1	copper	4.5	3.1	0.5	0.6	43	MPM
21523	55805	b	projectile point base	1	Silurian I	16.9	21.5	6.8	1.5	43	MPM
21523	55818	R1019	Copper awl	1	copper	123.7	6.1	4.6	10.2	45	MPM

Riverside Feature Catalog

Acc. No.	Cat. No		Item	Count	Material	L	W	Th	Wt (g)	F.	Location*
21523	55818	R1018	Copper awl	1	copper, wood, beaver tooth	147.7	9.2	9.8	49.9	45	MPM
21523	55727		Bifaces	110	pdc and galena				1624.0	63	MPM
	R943		projectile point	1	unid	61.0	32.0	7.0		63	OPM
	R619		projectile point	1	unid	64.0	38.0	11.0		63	OPM
	R904		projectile point	1	unid	70.0	33.0	8.0		63	OPM
	R981		projectile point	1	unid	65.0	30.0	9.0		63	OPM
	52444		conical point	1	copper	25.0	7.0	7.0	3.0	11S	UMMA
	52445		copper fragment	1	copper				0.5	11S	UMMA
	52474		copper beads	102	copper				208.0	14S	UMMA
	52473		Obsidian core	1	obsidian	152.0	109.0	80.0	1464.0	14S	UMMA
	52455		projectile point	1	unid				5.0	14S	UMMA
	45545	1	Ace of Spades Point	1	Copper	65.0	20.0	4.0	21.0	6S	UMMA
	45545	2	Ace of Spades Point	1	copper	67.0	20.0	5.0	23.0	6S	UMMA
	45545	3	Ace of Spades Point	1	copper	58.0	18.0	3.0	11.0	6S	UMMA
	45545	4	Ace of Spades Point	1	copper	72.0	18.0	3.0	18.0	6S	UMMA
	45535	3	Ace of Spades Point	1	copper	83.0	22.0	4.0	24.0	6S	UMMA
	45535	4	Ace of Spades Point	1	copper	55.0	15.0	3.0	6.0	6S	UMMA
	45534		awl	1	copper	142.0	14.0	5.0	57.0	6S	UMMA
	45535	1	conical point	1	copper	107.0	22.0	4.0	43.0	6S	UMMA
	45535	2	conical point	1	copper	80.0	21.0	4.0	31.0	6S	UMMA
	45547		Animal scapula	1	faunal					6S	UMMA
	45541		Antler wrench	1	faunal	130.0	20.0	15.0	19.0	6S	UMMA
	45538		Beaver tooth	1	faunal				0.5	6S	UMMA
	45539		Beaver tooth	9	faunal				13.0	6S	UMMA
			dog skulls	2	faunal				200.0	6S	UMMA
	45544		Lynx scapula	1	faunal				1.0	6S	UMMA
	45531	1	scrapers	2	krf				7.0	6S	UMMA
	45533		Ocher whetstone	1	ocher	53.0	39.0	8.0	30.0	6S	UMMA
	45537	1	projectile point	1	unid	55.0	20.0	5.0	6.0	6S	UMMA
	45537	2	projectile point	1	unid	20.0	11.0	5.0	1.0	6S	UMMA

Riverside Feature Catalog

Acc. No.	Cat. No		Item	Count	Material	L	W	Th	Wt (g)	F.	Location*
	45537	3	projectile point	1	unid	20.0	14.0	5.0	1.0	6S	UMMA
	45531	2	scrapers	14	unid				106.0	6S	UMMA

*Location	MPM	Milwuakee Public Museum
	OPM	Oshkosh Public Museum
	UMMA	University of Michigan Museum of Anthropology

APPENDIX IV

REIGH SITE CATALOG

Reigh Catalog

Acc. No		Item	Count	Material	Prov	L (mm)	W (mm)	Th (mm)	Wt (g)
1998.146	Wn1 CR2	Hafted biface	1	Rhyolite		31.5	21.0	6.6	3.6
1998.146	Wn1 B10-1	Antler tines	1	bone	Burial 10				
1998.146		Human and bone remains	7	bone	Burial 11				
1998.146	Wn1 B11-1	bone bone	6	bone	Burial 11				
1998.146	Wn1 B11-2	Antler handle	1	bone	Burial 11 (individual B)				
1998.146		Human remains	1	bone	Burial 11 (individual B)				
1998.146		Lower leg of Great Horned Owl	14	bone	Burial 11 (individual B)				
1998.146	Wn1 B11-1	Hafted biface	1	Galena	Burial 11 (individual B)	109.7	52.5	13.9	61.1
1998.146	Wn1 B11-A	Bone tube	1	Swan ulna	Burial 11 (individual B)				
1998.146		Deer long bone (MNI 1)	12	bone	Burial 13				
1998.146		Shell beads	4	Shell	Burial 13	7.5		2.4	
1998.146		copper beads	12	copper	Burial 13				
1998.146		Gorget	1	conch shell	Burial 13 (individual A)	132.0	51.0		
1998.146	Wn1 B18	Copper point	1	copper	Burial 18				
1998.146	Wn1 B21-1	Hafted biface	1	Galena	Burial 21	26.8	22.2	6.0	3.4
1998.146		Elk antler axe handle	1	bone	Burial 23				
1998.146	Wn1 B16-3	Worked swan humerii	2	bone	Burial 23				
1998.146	Wn1 B23	Copper point	1	copper	Burial 23				
1998.146	Wn1 B23-2	Hafted biface	1	Galena	Burial 23	72.3	40.0	13.0	34.5
1998.146	Wn1 B23-5	Hematite pebbles	3	Hematite	Burial 23				
1998.146	Wn1 B25-1	Hafted biface	1	Galena	Burial 25	75.2	40.9	10.2	27.7
1998.146	Wn1 B26-3b	Hematite pebble	1	Hematite	Burial 26				
1998.146	Wn1 B36	Conical copper point	1	copper	Burial 26 (individual B)				
1998.146	Wn1 B26-2	Hafted biface	1	PDC	Burial 26 (individual B)	89.8	44.0	13.0	48.4
1998.146	Wn1 B5	Elk antler axe handle	1	bone	Burial 5				

Reigh Catalog

Acc. No		Item	Count	Material	Prov	L (mm)	W (mm)	Th (mm)	Wt (g)
1998.146	Wn1 B5-2	Hafted biface	1	Galena	Burial 5	39.0	24.4	8.9	7.5
1998.146	Wn1 B5-4	Hafted biface	1	PDC	Burial 5	46.3	33.1	5.8	8.5
1998.146	Wn1 B5-3	Hafted biface	1	PDC	Burial 5	40.1	25.7	8.0	8.3
1998.146	Wn1 B6	Antler tines	2	bone	Burial 6				
1998.146		Crane bills	2	bone	Burial 6				
1998.146		Human remains	3	bone	Burial 6				
1998.146	10L	Copper "feather"	1	copper	Burial 6	49.1	8.5	1.7	2.7
1998.146	8L	Copper "feather"	1	copper	Burial 6	48.4	8.4	1.6	3.0
1998.146	?	Copper "feather"	1	copper	Burial 6	47.8	7.9	2.4	3.9
1998.146	6L	Copper "feather"	1	copper	Burial 6	49.0	8.7	1.8	3.8
1998.146	?	Copper "feather"	1	copper	Burial 6	38.1	5.6	1.6	1.0
1998.146	7L	Copper "feather"	1	copper	Burial 6	48.7	10.8	2.2	5.3
1998.146	2L	Copper "feather"	1	copper	Burial 6	53.5	9.5	2.1	4.9
1998.146	4L	Copper "feather"	1	copper	Burial 6	50.5	11.5	2.1	4.1
1998.146	11L	Copper "feather"	1	copper	Burial 6	47.5	11.0	2.0	2.3
1998.146	?	Copper "feather"	1	copper	Burial 6	38.6	7.2	2.2	2.8
1998.146	?	Copper "feather"	1	copper	Burial 6	32.9	6.8	2.4	1.5
1998.146	?	Copper "feather"	1	copper	Burial 6	32.8	9.5	1.2	1.3
1998.146	12L	Copper "feather"	1	copper	Burial 6	41.3	10.1	2.4	3.1
1998.146	?	Copper "feather"	1	copper	Burial 6	46.5	10.3	1.7	4.2
1998.146	5L	Copper "feather"	1	copper	Burial 6	51.1	9.6	1.5	3.7
1998.146	3L	Copper "feather"	1	copper	Burial 6	49.5	10.1	1.7	4.3
1998.146	?	Copper "feather"	1	copper	Burial 6	41.3	7.8	2.2	2.5
1998.146	?	Copper "feather"	1	copper	Burial 6	33.3	7.8	1.4	1.0
1998.146	?	Copper "feather"	1	copper	Burial 6	35.9	6.4	1.7	1.2
1998.146	?	Copper "feather"	1	copper	Burial 6	36.6	9.3	1.2	1.4
1998.146	4L	Copper "feather"	1	copper	Burial 6	42.1	11.7	1.5	2.8
1998.146	13	Copper "feather"	1	copper	Burial 6	37.5	11.5	2.8	2.4
1998.146	Wn1 R1	Biface	1	Galena	Burial 6	25.8	21.7	6.2	3.0
1998.146	Wn1 B8-2	Proximal Flake	1	Galena	Burial 8	37.9	23.4	6.7	5.9
1998.146	Wn1 B8-1	Hafted biface	1	Silurian	Burial 8	45.0	26.4	10.3	8.7
1998.146	Wn1 R6-1	Cord marked grit tempered	1	Ceramic	Plowzone				

Reigh Catalog

Acc. No		Item	Count	Material	Prov	L (mm)	W (mm)	Th (mm)	Wt (g)
		sherd							
1998.146	Wn1 R6-2	Cord marked grit tempered sherd	1	Ceramic	Plowzone				
1998.146	Wn1 R9	Hafted biface	1	Galena	Surf Burial Area	60.6	35.2	9.7	18.3
1998.146	Wn1 R3	Hafted biface	1	Galena	Surf Burial Area B 4	80.7	42.4	13.7	36.6
1998.146		Bone fragments	20	bone	Unprovenienced				

APPENDIX V

DUCK LAKE CATALOG

Duck Lake Catalog

Catalog No.	Provenience	Description	Material	No.	Wgt (g)	MLD (mm)	L (mm)	W (mm)	Th (mm)	Cortex	Platform
96E1-643	Surface	Angular Shatter	Unid	1	2.5	NA	NA	NA	NA	0	NA
96E1-644	Surface	Angular Shatter	Quartz	1	4.0	NA	NA	NA	NA	0	NA
96E1-80	Surface	Angular Shatter	PDC	1	12.3	NA	NA	NA	NA	0	NA
96E1-713.12	TEU 12 Level 4	Angular Shatter	PDC	1	0.6	NA	NA	NA	NA	0	NA
96E1-713.16	TEU 12 Level 4	Angular Shatter	PDC	1	0.2	NA	NA	NA	NA	0	NA
96E1-713.17	TEU 12 Level 4	Angular Shatter	PDC	1	0.6	NA	NA	NA	NA	0	NA
96E1-713.18	TEU 12 Level 4	Angular Shatter	Unid	1	0.2	NA	NA	NA	NA	2	NA
96E1-713.4	TEU 12 Level 4	Angular Shatter	Galena	1	0.6	NA	NA	NA	NA	0	NA
96E1-713.7	TEU 12 Level 4	Angular Shatter	Galena	1	3.6	NA	NA	NA	NA	0	NA
96E1-668.6	TEU 12 Level 5	Angular Shatter	Galena	1	0.2	NA	NA	NA	NA	0	NA
96E1-675	TEU 14 Level 1	Angular Shatter	Quartz	1	0.5	NA	NA	NA	NA	0	NA
96E1-607	TEU 14 Level 5	Angular Shatter	HBL	1	4.8	NA	NA	NA	NA	0	NA
96E1-752.1	TEU 14 Level 8	Angular Shatter	PDC	1	0.2	NA	NA	NA	NA	2	NA
96E1-753.1	TEU 14 Level 8	Angular Shatter	Quartz	1	0.7	NA	NA	NA	NA	0	NA
96E1-753.3	TEU 14 Level 8	Angular Shatter	Quartz	1	0.6	NA	NA	NA	NA	0	NA
96E1-753.5	TEU 14 Level 8	Angular Shatter	Quartz	1	0.3	NA	NA	NA	NA	0	NA
96E1-753.6	TEU 14 Level 8	Angular Shatter	Quartz	1	0.2	NA	NA	NA	NA	0	NA
96E1-756	TEU 14 Level 8	Angular Shatter	Quartz	1	0.1	NA	NA	NA	NA	0	NA
96E1-659.10	TEU 15 Level 4	Angular Shatter	Quartz	1	0.1	NA	NA	NA	NA	0	NA
96E1-659.18	TEU 15 Level 4	Angular Shatter	PDC	1	0.1	NA	NA	NA	NA	0	NA
96E1-659.7	TEU 15 Level 4	Angular Shatter	Quartz	1	0.1	NA	NA	NA	NA	0	NA
96E1-659.8	TEU 15 Level 4	Angular Shatter	Quartz	1	0.1	NA	NA	NA	NA	0	NA
96E1-661.1	TEU 15 Level 4	Angular Shatter	Quartz	1	0.2	NA	NA	NA	NA	0	NA
96E1-661.2	TEU 15 Level 4	Angular Shatter	Quartz	1	0.4	NA	NA	NA	NA	0	NA
96E1-715	TEU 15 Level 5	Angular Shatter	Quartzite	1	0.6	NA	NA	NA	NA	2	NA
96E1-759.13	TEU 15 Level 5	Angular Shatter	PDC	1	0.1	NA	NA	NA	NA	0	NA
96E1-759.2	TEU 15 Level 5	Angular Shatter	Quartz	1	0.1	NA	NA	NA	NA	0	NA
96E1-760.1	TEU 15 Level 5	Angular Shatter	Galena	1	0.3	NA	NA	NA	NA	0	NA
96E1-760.2	TEU 15 Level 5	Angular Shatter	Galena	1	0.8	NA	NA	NA	NA	0	NA
96E1-621.2	TEU 15 Level 6	Angular Shatter	Galena	1	0.3	NA	NA	NA	NA	0	NA
96E1-706.2	TEU 15 Level 7	Angular Shatter	Quartzite	1	0.7	NA	NA	NA	NA	0	NA
96E1-554.2	TEU 17 Level 11	Angular Shatter	Galena	1	0.2	NA	NA	NA	NA	0	NA

Duck Lake Catalog

Catalog No.	Provenience	Description	Material	No.	Wgt (g)	MLD (mm)	L (mm)	W (mm)	Th (mm)	Cortex	Platform
96E1-600.1	TEU 17 Level 11	Angular Shatter	Unid	1	5.6	NA	NA	NA	NA	0	NA
96E1-600.2	TEU 17 Level 11	Angular Shatter	Unid	1	6.4	NA	NA	NA	NA	0	NA
96E1-65	TEU 2 Level 7	Angular Shatter	PDC	1	0.1	NA	NA	NA	NA	0	NA
96E1-87.3	TEU 4 Level 7	Angular Shatter	Unid	1	0.7	NA	NA	NA	NA	0	NA
96E1-27.4	Locale B Surface	Flake Shatter	Unid	1	0.4	15.20	15.20	12.10	3.20	3	NA
96E1-27.5	Locale B Surface	Flake Shatter	Unid	1	0.5	17.20	17.20	9.50	4.80	3	NA
96E1-27.7	Locale B Surface	Flake Shatter	Hixton	1	0.6	19.10	19.10	8.80	3.90	0	NA
96E1-28.1	Locale B Surface	Flake Shatter	Quartzite	1	0.4	13.70	11.30	11.10	4.80	0	NA
96E1-28.2	Locale B Surface	Flake Shatter	Unid	1	0.2	13.40	11.60	10.20	2.90	0	NA
96E1-29.1	Locale B Surface	Flake Shatter	PDC	1	0.1	10.10	8.56	5.67	1.64	0	NA
96E1-29.3	Locale B Surface	Flake Shatter	Galena	1	0.1	9.47	8.50	7.46	2.35	0	NA
96E1-29.5	Locale B Surface	Flake Shatter	PDC	1	0.3	14.27	10.71	14.22	3.39	0	NA
96E1-29.6	Locale B Surface	Flake Shatter	PDC	1	0.1	9.84	8.14	7.37	1.65	0	NA
96E1-29.8	Locale B Surface	Flake Shatter	PDC	1	0.1	10.55	9.16	7.24	1.60	0	NA
96E1-30.1	Locale B Surface	Flake Shatter	Quartz	1	0.2	8.00	8.00	5.70	3.80	0	NA
96E1-39.3	Locale B Surface	Flake Shatter	PDC	1	0.1	10.49	10.49	5.13	2.89	0	NA
96E1-39.5	Locale B Surface	Flake Shatter	HBL	1	0.1	9.03	6.18	8.72	1.18	0	NA
96E1-39.8	Locale B Surface	Flake Shatter	PDC	1	0.1	9.83	9.79	4.14	0.93	0	NA
96E1-40.1	Locale B Surface	Flake Shatter	Unid	1	0.1	5.52	5.52	2.99	0.29	0	NA
96E1-40.10	Locale B Surface	Flake Shatter	PDC	1	0.1	4.63	4.61	3.86	0.78	0	NA
96E1-40.11	Locale B Surface	Flake Shatter	Galena	1	0.1	5.33	4.42	2.67	1.03	0	NA
96E1-40.13	Locale B Surface	Flake Shatter	PDC	1	0.1	2.65	2.65	1.92	0.33	0	NA
96E1-40.14	Locale B Surface	Flake Shatter	Unid	1	0.1	2.21	1.85	2.21	0.47	0	NA
96E1-40.16	Locale B Surface	Flake Shatter	PDC	1	0.1	3.77	3.72	1.90	0.42	0	NA
96E1-40.17	Locale B Surface	Flake Shatter	PDC	1	0.1	4.69	3.93	2.24	0.41	0	NA
96E1-40.18	Locale B Surface	Flake Shatter	PDC	1	0.1	6.25	5.23	3.34	0.62	0	NA
96E1-40.2	Locale B Surface	Flake Shatter	HBL	1	0.1	6.58	5.39	4.55	0.99	0	NA
96E1-40.20	Locale B Surface	Flake Shatter	HBL	1	0.1	4.91	4.91	1.93	1.16	0	NA
96E1-40.21	Locale B Surface	Flake Shatter	PDC	1	0.1	5.40	4.45	2.95	0.63	0	NA
96E1-40.22	Locale B Surface	Flake Shatter	PDC	1	0.1	6.32	6.09	6.22	1.13	0	NA
96E1-40.23	Locale B Surface	Flake Shatter	PDC	1	0.1	7.35	7.11	3.92	0.80	0	NA
96E1-40.24	Locale B Surface	Flake Shatter	PDC	1	0.1	5.31	4.51	5.07	1.28	0	NA

Duck Lake Catalog

Catalog No.	Provenience	Description	Material	No.	Wgt (g)	MLD (mm)	L (mm)	W (mm)	Th (mm)	Cortex	Platform
96E1-40.3	Locale B Surface	Flake Shatter	PDC	1	0.1	2.90	2.53	2.05	0.72	0	NA
96E1-40.4	Locale B Surface	Flake Shatter	Unid	1	0.1	7.13	4.25	6.81	1.25	0	NA
96E1-40.6	Locale B Surface	Flake Shatter	HBL	1	0.1	4.56	4.56	2.39	0.77	0	NA
96E1-40.9	Locale B Surface	Flake Shatter	HBL	1	0.1	6.15	2.59	6.15	0.79	0	NA
96E1-55	Locale B Surface	Flake Shatter	PDC	1	0.2	12.20	12.20	7.30	2.00	0	NA
96E1-8.1	Locale B Surface	Flake Shatter	Galena	1	0.5	16.90	16.90	9.60	3.80	0	NA
96E1-8.2	Locale B Surface	Flake Shatter	Galena	1	0.2	11.80	11.70	9.10	2.10	0	Complex
96E1-8.3	Locale B Surface	Flake Shatter	Quartz	1	0.2	8.70	8.70	7.10	3.80	0	NA
96E1-8.4	Locale B Surface	Flake Shatter	PDC	1	0.1	10.00	10.00	4.00	1.70	0	NA
96E1-9.1	Locale B Surface	Flake Shatter	Quartz	1	0.1	4.50	3.90	3.20	1.10	0	NA
96E1-9.2	Locale B Surface	Flake Shatter	Quartz	1	0.1	6.70	6.70	5.40	1.20	0	NA
96E1-9.3	Locale B Surface	Flake Shatter	Quartz	1	0.1	2.90	2.90	2.20	0.90	0	NA
96E1-9.4	Locale B Surface	Flake Shatter	PDC	1	0.1	4.70	3.90	3.10	0.80	0	NA
96E1-9.5	Locale B Surface	Flake Shatter	Quartz	1	0.1	3.90	3.40	3.10	1.70	0	NA
96E1-9.6	Locale B Surface	Flake Shatter	Quartz	1	0.1	4.20	3.10	2.90	1.60	0	NA
96E1-9.7	Locale B Surface	Flake Shatter	Quartz	1	0.1	6.10	6.10	4.10	2.00	0	NA
96E1-19	ST 20S 15E	Flake Shatter	Galena	1	0.1	3.07	3.00	1.90	0.38	0	NA
96E1-5	ST 5S 0E	Flake Shatter	PDC	1	0.1	4.20	4.00	3.60	0.90	0	NA
96E1-25	ST 60S 50E	Flake Shatter	HBL	1	0.2	12.00	9.50	6.30	3.90	0	NA
96E1-24	ST 65S 50E	Flake Shatter	Quartz	1	0.2	10.00	10.00	9.20	0.30	0	NA
96E1-70.1	TEU 1 Level 3	Flake Shatter	Galena	1	0.1	14.10	12.50	8.80	1.20	0	NA
96E1-70.2	TEU 1 Level 3	Flake Shatter	Galena	1	0.1	10.80	10.80	7.00	2.00	0	NA
96E1-66.1	TEU 1 Level 6	Flake Shatter	Galena	1	0.1	3.17	2.43	2.06	0.48	0	NA
96E1-66.2	TEU 1 Level 6	Flake Shatter	Unid	1	0.1	2.73	2.66	0.82	0.49	0	NA
96E1-66.4	TEU 1 Level 6	Flake Shatter	Galena	1	0.1	6.70	6.63	4.01	0.93	0	NA
96E1-68.3	TEU 1 Level 6	Flake Shatter	Galena	1	0.1	8.34	7.32	5.88	0.71	0	NA
96E1-72.1	TEU 1 Level 7	Flake Shatter	PDC	1	0.1	2.64	2.52	2.16	0.36	0	NA
96E1-72.2	TEU 1 Level 7	Flake Shatter	Galena	1	0.1	5.91	3.84	5.88	0.65	0	NA
96E1-72.3	TEU 1 Level 7	Flake Shatter	Galena	1	0.1	6.20	5.69	2.98	0.64	0	NA
96E1-94.2	TEU 1 Level 7	Flake Shatter	Galena	1	0.1	4.81	4.32	3.13	0.61	0	NA
96E1-94.4	TEU 1 Level 7	Flake Shatter	PDC	1	0.1	5.85	5.80	5.36	1.02	0	NA
96E1-82.1	TEU 11 Level 3	Flake Shatter	PDC	1	0.1	4.58	3.41	4.38	1.14	0	NA

Duck Lake Catalog

Catalog No.	Provenience	Description	Material	No.	Wgt (g)	MLD (mm)	L (mm)	W (mm)	Th (mm)	Cortex	Platform
96E1-82.2	TEU 11 Level 3	Flake Shatter	PDC	1	0.1	4.85	4.85	2.41	1.32	0	NA
96E1-74.1	TEU 11 Level 8	Flake Shatter	Quartzite	1	0.1	2.33	2.33	1.93	0.78	0	NA
96E1-62.1	TEU 11 Level 9	Flake Shatter	PDC	1	0.1	5.23	3.06	3.11	1.18	0	NA
96E1-62.2	TEU 11 Level 9	Flake Shatter	Quartz	1	0.1	6.40	6.20	2.74	1.18	0	NA
96E1-747.10	TEU 12 Level 13	Flake Shatter	Unid	1	0.1	10.90	10.80	9.10	1.30	0	NA
96E1-747.11	TEU 12 Level 13	Flake Shatter	Quartzite	1	0.1	8.30	8.30	4.90	0.80	0	NA
96E1-747.12	TEU 12 Level 13	Flake Shatter	Unid	1	0.2	12.80	9.70	9.20	1.80	0	NA
96E1-747.2	TEU 12 Level 13	Flake Shatter	Unid	1	0.9	23.20	22.80	14.20	3.10	0	NA
96E1-747.3	TEU 12 Level 13	Flake Shatter	Unid	1	0.2	13.60	9.90	9.70	2.20	0	NA
96E1-747.4	TEU 12 Level 13	Flake Shatter	Unid	1	0.3	16.20	14.10	9.10	2.90	0	NA
96E1-747.5	TEU 12 Level 13	Flake Shatter	Unid	1	0.2	11.60	10.70	10.40	3.00	0	NA
96E1-747.6	TEU 12 Level 13	Flake Shatter	Unid	1	0.3	15.70	15.70	8.90	2.20	0	NA
96E1-747.8	TEU 12 Level 13	Flake Shatter	Galena	1	0.2	13.40	13.10	9.80	2.10	0	NA
96E1-747.9	TEU 12 Level 13	Flake Shatter	Unid	1	0.1	14.20	14.10	5.50	1.40	0	NA
96E1-745.1	TEU 12 Level 3	Flake Shatter	Quartz	1	0.1	4.70	4.20	3.00	0.80	0	NA
96E1-745.2	TEU 12 Level 3	Flake Shatter	Quartz	1	0.1	5.30	5.30	4.60	1.20	0	NA
96E1-745.3	TEU 12 Level 3	Flake Shatter	Quartz	1	0.1	5.30	4.30	4.00	1.00	0	NA
96E1-746.1	TEU 12 Level 3	Flake Shatter	Unid	1	0.1	20.00	17.50	14.50	3.80	1	NA
96E1-746.2	TEU 12 Level 3	Flake Shatter	Unid	1	0.1	10.70	10.50	6.10	1.60	2	NA
96E1-750.1	TEU 12 Level 3	Flake Shatter	PDC	1	0.2	10.70	8.40	8.80	3.60	2	NA
96E1-750.10	TEU 12 Level 3	Flake Shatter	Galena	1	0.1	10.00	10.00	5.80	2.80	0	NA
96E1-750.11	TEU 12 Level 3	Flake Shatter	Galena	1	0.1	8.40	7.80	7.70	1.30	0	NA
96E1-750.12	TEU 12 Level 3	Flake Shatter	PDC	1	0.1	8.10	7.20	5.70	1.20	0	NA
96E1-750.14	TEU 12 Level 3	Flake Shatter	Galena	1	0.1	9.50	9.30	4.70	1.30	0	NA
96E1-750.16	TEU 12 Level 3	Flake Shatter	Galena	1	0.1	7.20	6.80	5.10	1.00	0	NA
96E1-750.18	TEU 12 Level 3	Flake Shatter	PDC	1	0.1	6.90	6.00	5.10	1.10	0	NA
96E1-750.19	TEU 12 Level 3	Flake Shatter	PDC	1	0.1	6.30	5.20	5.10	1.20	0	NA
96E1-750.2	TEU 12 Level 3	Flake Shatter	Galena	1	0.3	19.70	19.20	10.20	1.90	0	NA
96E1-750.3	TEU 12 Level 3	Flake Shatter	PDC	1	0.1	8.70	7.80	7.60	3.40	0	NA
96E1-750.6	TEU 12 Level 3	Flake Shatter	Galena	1	0.1	9.50	9.50	7.30	2.60	0	NA
96E1-750.9	TEU 12 Level 3	Flake Shatter	PDC	1	0.1	12.90	12.40	5.10	2.20	0	NA
96E1-764	TEU 12 Level 3	Flake Shatter	PDC	1	0.1	8.04	4.53	8.04	2.18	0	NA

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Catalog No.	Provenience	Description	Material	No.	Wgt (g)	MLD (mm)	L (mm)	W (mm)	Th (mm)	Cortex	Platform
96E1-682.1	TEU 12 Level 4	Flake Shatter	PDC	1	0.1	2.90	2.81	1.98	0.95	0	NA
96E1-682.4	TEU 12 Level 4	Flake Shatter	PDC	1	0.1	5.57	5.57	4.07	0.94	0	NA
96E1-682.7	TEU 12 Level 4	Flake Shatter	Galena	1	0.1	7.84	7.80	4.30	0.54	0	NA
96E1-682.8	TEU 12 Level 4	Flake Shatter	PDC	1	0.1	6.45	6.02	3.66	0.78	0	NA
96E1-712.17	TEU 12 Level 4	Flake Shatter	PDC	1	0.1	10.19	9.20	7.35	1.82	0	NA
96E1-712.4	TEU 12 Level 4	Flake Shatter	PDC	1	0.2	13.05	12.06	10.34	2.47	0	NA
96E1-712.6	TEU 12 Level 4	Flake Shatter	Galena	1	0.1	10.06	6.89	9.66	1.94	0	NA
96E1-712.7	TEU 12 Level 4	Flake Shatter	PDC	1	0.2	17.96	17.96	9.39	2.72	0	NA
96E1-712.8	TEU 12 Level 4	Flake Shatter	PDC	1	0.1	13.04	12.68	7.67	1.13	0	NA
96E1-713.10	TEU 12 Level 4	Flake Shatter	PDC	1	0.4	13.18	11.10	8.34	5.12	0	NA
96E1-713.11	TEU 12 Level 4	Flake Shatter	Unid	1	0.3	18.75	17.62	6.00	2.85	0	NA
96E1-713.14	TEU 12 Level 4	Flake Shatter	Galena	1	0.2	12.23	9.81	6.23	4.97	1	NA
96E1-713.15	TEU 12 Level 4	Flake Shatter	Unid	1	0.4	15.50	14.06	8.54	4.46	0	NA
96E1-713.2	TEU 12 Level 4	Flake Shatter	Unid	1	0.1	2.56	2.56	1.50	0.35	0	NA
96E1-713.6	TEU 12 Level 4	Flake Shatter	PDC	1	0.4	18.45	18.17	6.96	2.62	0	NA
96E1-713.8	TEU 12 Level 4	Flake Shatter	Galena	1	0.8	18.66	18.17	13.38	4.34	0	NA
96E1-713.9	TEU 12 Level 4	Flake Shatter	HBL	1	0.3	11.18	10.67	7.14	3.49	2	NA
96E1-719.3	TEU 12 Level 4	Flake Shatter	Galena	1	0.2	14.17	13.12	9.78	1.96	0	NA
96E1-719.5	TEU 12 Level 4	Flake Shatter	Unid	1	0.7	19.90	17.63	11.94	2.93	1	NA
96E1-648	TEU 12 Level 5	Flake Shatter	Quartz	1	0.4	19.36	19.36	10.16	2.36	0	NA
96E1-651.2	TEU 12 Level 5	Flake Shatter	HBL	1	1.6	20.19	11.71	20.14	7.29	0	NA
96E1-651.3	TEU 12 Level 5	Flake Shatter	HBL	1	5.8	28.81	19.02	28.75	11.90	0	NA
96E1-668.1	TEU 12 Level 5	Flake Shatter	Unid	1	0.1	10.70	10.70	10.09	1.65	0	NA
96E1-668.2	TEU 12 Level 5	Flake Shatter	Galena	1	0.3	17.50	9.06	17.50	2.25	0	NA
96E1-668.4	TEU 12 Level 5	Flake Shatter	PDC	1	0.5	19.27	19.23	14.56	2.30	0	NA
96E1-668.5	TEU 12 Level 5	Flake Shatter	PDC	1	0.1	8.28	8.28	4.94	1.42	0	NA
96E1-668.7	TEU 12 Level 5	Flake Shatter	PDC	1	0.1	9.99	9.99	4.80	0.72	0	NA
96E1-680	TEU 12 Level 5	Flake Shatter	Unid	1	1.3	21.80	21.50	14.80	4.70	0	NA
96E1-691.2	TEU 12 Level 5	Flake Shatter	Unid	1	0.2	10.00	10.00	9.70	3.00	3	NA
96E1-693.2	TEU 12 Level 5	Flake Shatter	Galena	1	0.2	13.20	12.50	11.50	2.40	1	NA
96E1-638	TEU 12 Level 6	Flake Shatter	Galena	1	0.1	5.10	5.10	4.30	1.20	1	NA
96E1-639	TEU 12 Level 6	Flake Shatter	Galena	1	0.7	20.00	20.00	11.00	4.70	0	NA

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Catalog No.	Provenience	Description	Material	No.	Wgt (g)	MLD (mm)	L (mm)	W (mm)	Th (mm)	Cortex	Platform
96E1-650	TEU 12 Level 6	Flake Shatter	Unid	1	0.8	21.57	19.89	11.39	4.77	0	NA
96E1-652	TEU 12 Level 6	Flake Shatter	PDC	1	0.2	14.31	13.20	6.68	2.69	0	NA
96E1-666	TEU 12 Level 6	Flake Shatter	Galena	1	0.5	14.80	14.40	10.00	4.40	0	NA
96E1-670	TEU 12 Level 6	Flake Shatter	Unid	1	0.1	9.02	5.42	8.84	1.37	3	NA
96E1-685	TEU 12 Level 7	Flake Shatter	Galena	1	0.2	12.57	10.97	10.72	2.33	0	NA
96E1-687.2	TEU 12 Level 7	Flake Shatter	Galena	1	0.2	11.80	7.77	11.42	2.73	0	NA
96E1-622	TEU 13 Level 2	Flake Shatter	Unid	1	0.1	8.93	6.73	8.93	1.73	0	NA
96E1-642.2	TEU 13 Level 5	Flake Shatter	PDC	1	0.6	17.70	17.20	11.40	3.90	0	NA
96E1-566.2	TEU 13 Level 7	Flake Shatter	PDC	1	0.2	14.52	13.17	7.95	2.33	0	NA
96E1-566.3	TEU 13 Level 7	Flake Shatter	Unid	1	0.4	17.32	17.02	7.97	3.62	0	NA
96E1-608.1	TEU 14 Level 5	Flake Shatter	PDC	1	0.1	4.57	4.50	2.15	1.04	0	NA
96E1-608.2	TEU 14 Level 5	Flake Shatter	Quartz	1	0.4	13.92	13.88	7.42	4.23	0	NA
96E1-608.3	TEU 14 Level 5	Flake Shatter	Quartz	1	0.3	13.33	12.21	11.58	2.57	0	NA
96E1-608.4	TEU 14 Level 5	Flake Shatter	Galena	1	0.1	10.77	9.04	7.78	2.26	0	NA
96E1-608.5	TEU 14 Level 5	Flake Shatter	PDC	1	0.1	8.08	4.80	6.35	1.90	0	NA
96E1-608.6	TEU 14 Level 5	Flake Shatter	PDC	1	0.1	12.79	11.54	7.42	1.50	0	NA
96E1-608.7	TEU 14 Level 5	Flake Shatter	PDC	1	0.1	11.77	9.85	8.57	1.56	0	NA
96E1-551.3	TEU 14 Level 7	Flake Shatter	Quartzite	1	0.2	12.10	12.10	8.70	2.10	0	NA
96E1-683	TEU 14 Level 8	Flake Shatter	Galena	1	0.1	6.18	5.64	3.65	0.95	0	NA
96E1-751.2	TEU 14 Level 8	Flake Shatter	Basalt	1	1.1	18.78	18.02	14.26	4.69	0	NA
96E1-751.3	TEU 14 Level 8	Flake Shatter	Unid	1	0.7	13.53	13.07	10.36	6.47	0	NA
96E1-752.2	TEU 14 Level 8	Flake Shatter	Galena	1	5.7	34.72	32.18	22.69	10.29	3	NA
96E1-753.2	TEU 14 Level 8	Flake Shatter	Quartz	1	0.9	17.26	17.16	8.83	5.73	0	NA
96E1-753.4	TEU 14 Level 8	Flake Shatter	Quartz	1	0.3	12.24	12.20	6.89	5.18	0	NA
96E1-755.2	TEU 14 Level 8	Flake Shatter	PDC	1	0.1	5.45	3.06	5.45	1.08	0	NA
96E1-755.4	TEU 14 Level 8	Flake Shatter	PDC	1	0.1	4.77	4.54	3.74	2.12	0	NA
96E1-755.5	TEU 14 Level 8	Flake Shatter	Quartz	1	0.1	8.40	5.85	8.24	1.16	0	NA
96E1-755.6	TEU 14 Level 8	Flake Shatter	Quartz	1	0.1	7.42	5.24	6.66	1.68	0	NA
96E1-758	TEU 14 Level 8	Flake Shatter	PDC	1	0.4	21.20	21.20	8.90	2.80	0	NA
96E1-732.2	TEU 15 Level 3	Flake Shatter	PDC	1	0.1	2.24	2.24	1.81	0.95	0	NA
96E1-732.3	TEU 15 Level 3	Flake Shatter	Quartz	1	0.1	4.44	3.10	4.44	1.66	0	NA
96E1-732.4	TEU 15 Level 3	Flake Shatter	PDC	1	0.1	5.13	3.80	3.27	0.33	0	NA

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Catalog No.	Provenience	Description	Material	No.	Wgt (g)	MLD (mm)	L (mm)	W (mm)	Th (mm)	Cortex	Platform
96E1-732.5	TEU 15 Level 3	Flake Shatter	PDC	1	0.1	3.71	2.82	3.61	0.48	0	NA
96E1-732.6	TEU 15 Level 3	Flake Shatter	PDC	1	0.1	5.71	3.73	5.30	1.06	0	NA
96E1-732.7	TEU 15 Level 3	Flake Shatter	Unid	1	0.1	6.50	6.46	4.95	1.76	3	NA
96E1-732.8	TEU 15 Level 3	Flake Shatter	PDC	1	0.1	7.70	7.68	4.09	0.74	0	NA
96E1-732.9	TEU 15 Level 3	Flake Shatter	PDC	1	0.1	7.33	3.86	7.33	0.95	0	NA
96E1-737	TEU 15 Level 3	Flake Shatter	Galena	1	0.1	10.82	10.09	7.44	1.05	0	NA
96E1-739.2	TEU 15 Level 3	Flake Shatter	PDC	1	0.5	22.10	7.90	22.40	2.50	0	NA
96E1-585	TEU 15 Level 4	Flake Shatter	PDC	1	0.8	22.23	21.66	10.83	3.70	0	NA
96E1-659.1	TEU 15 Level 4	Flake Shatter	PDC	1	0.1	5.88	5.39	4.17	1.22	0	NA
96E1-659.11	TEU 15 Level 4	Flake Shatter	Unid	1	0.1	6.44	5.67	4.49	0.37	0	NA
96E1-659.12	TEU 15 Level 4	Flake Shatter	PDC	1	0.1	6.03	4.65	6.03	1.38	0	NA
96E1-659.13	TEU 15 Level 4	Flake Shatter	PDC	1	0.1	6.76	4.41	5.24	1.77	0	NA
96E1-659.15	TEU 15 Level 4	Flake Shatter	PDC	1	0.1	6.82	5.29	6.46	1.65	0	NA
96E1-659.16	TEU 15 Level 4	Flake Shatter	Galena	1	0.1	5.66	4.83	5.66	0.84	0	NA
96E1-659.17	TEU 15 Level 4	Flake Shatter	PDC	1	0.1	4.63	4.52	2.20	1.49	0	NA
96E1-659.2	TEU 15 Level 4	Flake Shatter	PDC	1	0.1	8.18	7.96	5.30	0.91	0	NA
96E1-659.20	TEU 15 Level 4	Flake Shatter	PDC	1	0.1	8.88	4.36	7.52	0.91	0	NA
96E1-659.21	TEU 15 Level 4	Flake Shatter	PDC	1	0.1	7.78	6.52	7.78	1.47	0	NA
96E1-659.22	TEU 15 Level 4	Flake Shatter	PDC	1	0.1	2.89	2.11	2.60	1.10	0	NA
96E1-659.23	TEU 15 Level 4	Flake Shatter	PDC	1	0.1	5.47	3.22	4.67	0.82	0	NA
96E1-659.24	TEU 15 Level 4	Flake Shatter	PDC	1	0.1	5.61	5.16	3.47	0.95	0	NA
96E1-659.26	TEU 15 Level 4	Flake Shatter	Quartz	1	0.1	4.52	4.27	1.95	1.51	0	NA
96E1-659.27	TEU 15 Level 4	Flake Shatter	PDC	1	0.1	7.53	4.60	5.51	1.34	0	NA
96E1-659.28	TEU 15 Level 4	Flake Shatter	PDC	1	0.1	7.51	2.48	7.51	1.17	0	NA
96E1-659.29	TEU 15 Level 4	Flake Shatter	PDC	1	0.1	7.13	6.95	3.19	1.04	0	NA
96E1-659.3	TEU 15 Level 4	Flake Shatter	Quartz	1	0.1	6.58	5.71	6.05	3.53	2	NA
96E1-659.30	TEU 15 Level 4	Flake Shatter	PDC	1	0.1	4.10	3.88	3.55	1.07	0	NA
96E1-659.31	TEU 15 Level 4	Flake Shatter	Galena	1	0.1	8.57	4.57	8.47	1.07	0	NA
96E1-659.5	TEU 15 Level 4	Flake Shatter	Galena	1	0.1	8.91	8.45	3.90	2.14	0	NA
96E1-659.6	TEU 15 Level 4	Flake Shatter	PDC	1	0.1	6.38	4.27	6.32	1.80	0	NA
96E1-659.9	TEU 15 Level 4	Flake Shatter	Quartz	1	0.1	3.97	3.97	2.73	1.57	0	NA
96E1-660.1	TEU 15 Level 4	Flake Shatter	Quartz	1	0.1	5.80	3.86	5.80	1.09	0	NA

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Catalog No.	Provenience	Description	Material	No.	Wgt (g)	MLD (mm)	L (mm)	W (mm)	Th (mm)	Cortex	Platform
96E1-660.10	TEU 15 Level 4	Flake Shatter	PDC	1	0.1	14.90	13.30	8.68	1.25	0	NA
96E1-660.11	TEU 15 Level 4	Flake Shatter	PDC	1	0.3	13.77	12.66	7.47	2.22	0	NA
96E1-660.13	TEU 15 Level 4	Flake Shatter	PDC	1	0.1	9.16	7.92	6.50	1.39	0	NA
96E1-660.14	TEU 15 Level 4	Flake Shatter	PDC	1	0.1	8.29	8.03	5.76	1.81	0	NA
96E1-660.2	TEU 15 Level 4	Flake Shatter	Galena	1	0.1	12.37	10.47	4.97	1.70	0	NA
96E1-660.3	TEU 15 Level 4	Flake Shatter	PDC	1	0.3	12.65	12.33	9.08	3.16	0	NA
96E1-660.5	TEU 15 Level 4	Flake Shatter	Galena	1	0.2	10.91	10.88	7.17	3.66	0	NA
96E1-660.6	TEU 15 Level 4	Flake Shatter	PDC	1	0.1	13.13	12.75	4.17	1.66	0	NA
96E1-660.7	TEU 15 Level 4	Flake Shatter	PDC	1	0.1	11.66	10.95	6.36	1.40	0	NA
96E1-660.8	TEU 15 Level 4	Flake Shatter	PDC	1	0.1	10.05	8.58	7.77	1.14	0	NA
96E1-660.9	TEU 15 Level 4	Flake Shatter	PDC	1	0.2	11.42	9.60	9.50	2.29	0	NA
96E1-661.3	TEU 15 Level 4	Flake Shatter	Quartz	1	0.3	12.15	12.08	6.59	4.55	0	NA
96E1-661.4	TEU 15 Level 4	Flake Shatter	PDC	1	1.0	22.58	22.56	7.03	5.38	0	NA
96E1-662.1	TEU 15 Level 4	Flake Shatter	PDC	1	0.1	11.08	10.64	7.72	1.39	0	NA
96E1-662.3	TEU 15 Level 4	Flake Shatter	PDC	1	0.8	20.38	12.98	19.79	5.99	0	NA
96E1-663	TEU 15 Level 4	Flake Shatter	PDC	1	0.3	14.78	14.17	11.10	2.77	0	NA
96E1-665	TEU 15 Level 4	Flake Shatter	Galena	1	1.1	23.40	21.50	16.30	4.00	0	NA
96E1-696	TEU 15 Level 4	Flake Shatter	Quartz	1	0.7	19.60	16.50	12.00	6.00	0	NA
96E1-688	TEU 15 Level 5	Flake Shatter	PDC	1	2.7	30.80	26.10	18.70	0.70	0	NA
96E1-759.1	TEU 15 Level 5	Flake Shatter	Quartz	1	0.1	7.56	7.50	6.57	2.63	0	NA
96E1-759.11	TEU 15 Level 5	Flake Shatter	PDC	1	0.1	5.24	4.58	4.46	0.63	0	NA
96E1-759.12	TEU 15 Level 5	Flake Shatter	PDC	1	0.1	6.94	4.59	6.82	1.98	0	NA
96E1-759.14	TEU 15 Level 5	Flake Shatter	PDC	1	0.1	3.98	3.36	3.98	1.11	0	NA
96E1-759.4	TEU 15 Level 5	Flake Shatter	PDC	1	0.1	3.83	3.72	2.88	0.44	0	NA
96E1-759.6	TEU 15 Level 5	Flake Shatter	PDC	1	0.1	5.72	5.49	2.91	1.05	0	NA
96E1-759.7	TEU 15 Level 5	Flake Shatter	PDC	1	0.1	4.33	2.93	3.71	0.61	0	NA
96E1-759.8	TEU 15 Level 5	Flake Shatter	PDC	1	0.1	6.85	4.16	6.62	2.25	0	NA
96E1-759.9	TEU 15 Level 5	Flake Shatter	PDC	1	0.1	6.39	6.39	3.70	0.90	0	NA
96E1-760.3	TEU 15 Level 5	Flake Shatter	Galena	1	0.7	26.23	25.99	7.50	4.05	0	NA
96E1-763	TEU 15 Level 5	Flake Shatter	PDC	1	0.5	18.20	18.20	11.90	3.00	0	NA
96E1-766.1	TEU 15 Level 5	Flake Shatter	Unid	1	0.1	7.89	4.54	7.89	1.64	0	NA
96E1-766.2	TEU 15 Level 5	Flake Shatter	PDC	1	0.1	8.25	5.91	6.23	3.58	0	NA

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Catalog No.	Provenience	Description	Material	No.	Wgt (g)	MLD (mm)	L (mm)	W (mm)	Th (mm)	Cortex	Platform
96E1-766.3	TEU 15 Level 5	Flake Shatter	PDC	1	0.1	11.34	10.95	7.48	1.34	0	NA
96E1-768	TEU 15 Level 5	Flake Shatter	Quartz	1	0.1	8.24	8.14	3.52	2.76	0	NA
91E1-646.1	TEU 15 Level 6	Flake Shatter	PDC	1	1.7	19.09	19.41	16.43	7.00	1	NA
96E1-620.1	TEU 15 Level 6	Flake Shatter	PDC	1	0.1	5.55	5.55	3.77	0.58	0	NA
96E1-620.10	TEU 15 Level 6	Flake Shatter	Quartz	1	0.1	4.44	2.79	4.39	1.69	0	NA
96E1-620.11	TEU 15 Level 6	Flake Shatter	PDC	1	0.1	5.46	5.40	3.10	1.10	0	NA
96E1-620.3	TEU 15 Level 6	Flake Shatter	Quartz	1	0.1	3.85	3.53	2.51	1.49	0	NA
96E1-620.4	TEU 15 Level 6	Flake Shatter	Quartz	1	0.1	3.10	2.34	1.95	1.20	0	NA
96E1-620.6	TEU 15 Level 6	Flake Shatter	Galena	1	0.1	5.63	5.63	4.24	1.28	0	NA
96E1-620.7	TEU 15 Level 6	Flake Shatter	PDC	1	0.1	5.43	3.21	5.43	1.14	0	NA
96E1-620.8	TEU 15 Level 6	Flake Shatter	PDC	1	0.1	8.82	8.27	3.87	1.83	0	NA
96E1-621.1	TEU 15 Level 6	Flake Shatter	Galena	1	0.1	18.91	14.15	10.95	6.89	0	NA
96E1-621.3	TEU 15 Level 6	Flake Shatter	PDC	1	0.2	10.79	7.21	9.52	2.88	0	NA
96E1-645.1	TEU 15 Level 6	Flake Shatter	PDC	1	0.1	12.61	12.46	6.35	1.27	0	NA
96E1-645.2	TEU 15 Level 6	Flake Shatter	Galena	1	0.2	13.13	13.13	6.77	2.74	0	NA
96E1-645.3	TEU 15 Level 6	Flake Shatter	PDC	1	0.1	10.21	9.23	4.19	2.68	0	NA
96E1-645.6	TEU 15 Level 6	Flake Shatter	PDC	1	0.1	10.27	10.05	5.24	0.98	0	NA
96E1-645.8	TEU 15 Level 6	Flake Shatter	PDC	1	0.1	10.33	10.33	6.14	0.58	0	NA
96E1-645.9	TEU 15 Level 6	Flake Shatter	PDC	1	0.1	10.50	7.89	8.37	1.14	0	NA
96E1-656	TEU 15 Level 6	Flake Shatter	PDC	1	0.6	16.72	10.48	16.72	5.21	0	NA
96E1-609.1	TEU 15 Level 7	Flake Shatter	Quartz	1	0.1	6.46	4.97	6.36	2.40	0	NA
96E1-609.2	TEU 15 Level 7	Flake Shatter	PDC	1	0.4	13.18	8.85	12.75	3.55	0	NA
96E1-703.2	TEU 15 Level 7	Flake Shatter	Unid	1	0.1	5.10	4.80	3.90	0.70	0	NA
96E1-707.1	TEU 15 Level 7	Flake Shatter	Unid	1	0.1	8.70	8.70	4.90	1.60	0	NA
96E1-708	TEU 15 Level 7	Flake Shatter	PDC	1	0.2	8.80	7.57	7.38	3.90	0	NA
96E1-709.1	TEU 15 Level 7	Flake Shatter	PDC	1	0.1	3.53	3.08	3.53	1.07	0	NA
96E1-709.2	TEU 15 Level 7	Flake Shatter	PDC	1	0.1	3.93	3.93	2.35	1.25	0	NA
96E1-554.1	TEU 17 Level 11	Flake Shatter	PDC	1	0.1	7.86	7.65	5.46	1.30	0	NA
96E1-554.3	TEU 17 Level 11	Flake Shatter	PDC	1	0.3	13.47	9.84	10.39	3.29	0	NA
96E1-726.2	TEU 17 Level 7	Flake Shatter	PDC	1	0.1	5.44	5.36	2.77	0.61	0	NA
96E1-734.1	TEU 17 Level 7	Flake Shatter	PDC	1	0.3	11.92	10.00	11.30	3.36	0	NA
96E1-734.2	TEU 17 Level 7	Flake Shatter	PDC	1	0.3	18.45	17.86	11.24	1.62	0	NA

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Catalog No.	Provenience	Description	Material	No.	Wgt (g)	MLD (mm)	L (mm)	W (mm)	Th (mm)	Cortex	Platform
96E1-655	TEU 19 Level 4	Flake Shatter	PDC	1	0.1	3.88	2.25	3.81	0.66	0	NA
96E1-624.1	TEU 20 Level 4	Flake Shatter	PDC	1	0.3	15.52	14.83	10.16	2.54	0	NA
96E1-624.3	TEU 20 Level 4	Flake Shatter	PDC	1	0.1	8.48	8.34	7.36	0.97	0	NA
96E1-625.1	TEU 20 Level 4	Flake Shatter	PDC	1	1.1	20.56	19.66	15.17	4.48	0	NA
96E1-626	TEU 20 Level 4	Flake Shatter	PDC	1	0.1	6.45	5.05	5.12	0.70	0	NA
96E1-627	TEU 20 Level 4	Flake Shatter	Unid	1	0.3	11.87	9.66	10.32	4.70	0	NA
96E1-628	TEU 20 Level 4	Flake Shatter	Quartzite	1	0.1	11.40	11.40	8.10	2.20	0	NA
96E1-631	TEU 20 Level 5	Flake Shatter	Quartz	1	0.2	11.70	11.20	5.00	4.60	0	NA
96E1-630	TEU 20 Level 6	Flake Shatter	PDC	1	0.1	4.27	3.09	4.27	0.73	0	NA
96E1-632	TEU 20 Level 7	Flake Shatter	PDC	1	0.1	6.10	5.90	4.00	1.10	0	NA
96E1-677	TEU 21 Level 6	Flake Shatter	PDC	1	0.1	8.26	7.46	8.26	2.45	0	NA
96E1-83.1	TEU 4 Level 7	Flake Shatter	PDC	1	0.1	6.22	6.15	2.68	0.84	0	NA
96E1-83.2	TEU 4 Level 7	Flake Shatter	PDC	1	0.1	5.62	5.16	5.22	0.62	0	NA
96E1-84.1	TEU 4 Level 7	Flake Shatter	Galena	1	0.7	20.41	16.36	14.85	4.84	0	NA
96E1-85.8	TEU 4 Level 7	Flake Shatter	Unid	1	0.1	10.36	10.16	6.13	0.77	0	NA
96E1-86.1	TEU 4 Level 7	Flake Shatter	Basalt	1	0.1	10.37	9.56	9.09	1.52	0	NA
96E1-86.2	TEU 4 Level 7	Flake Shatter	Basalt	1	0.3	14.34	14.16	12.00	1.91	0	NA
96E1-86.3	TEU 4 Level 7	Flake Shatter	Basalt	1	0.8	17.60	16.94	15.19	4.21	0	NA
96E1-86.5	TEU 4 Level 7	Flake Shatter	Quartzite	1	0.1	8.48	7.96	6.59	1.88	1	NA
96E1-86.6	TEU 4 Level 7	Flake Shatter	Quartzite	1	0.5	16.78	16.34	7.30	5.21	0	NA
96E1-87.1	TEU 4 Level 7	Flake Shatter	Quartzite	1	0.3	11.70	9.87	8.42	4.60	2	NA
96E1-87.2	TEU 4 Level 7	Flake Shatter	Galena	1	0.3	13.32	13.32	5.76	3.90	0	NA
96E1-87.4	TEU 4 Level 7	Flake Shatter	Galena	1	0.7	19.20	18.67	12.71	7.50	0	NA
96E1-98.2	TEU 4 Level 7	Flake Shatter	Unid	1	0.1	9.85	9.10	6.71	1.23	0	NA
96E1-237	TEU 4 Level 8	Flake Shatter	PDC	1	0.6	17.40	17.40	12.90	2.80	0	NA
96E1-239	TEU 4 Level 8	Flake Shatter	PDC	1	0.9	22.10	21.00	11.20	5.00	0	NA
96E1-99.1	TEU 7-Near Surface	Flake Shatter	PDC	1	0.1	5.04	4.73	1.92	1.01	0	NA
96E1-99.2	TEU 7-Near Surface	Flake Shatter	PDC	1	0.1	4.78	4.16	2.91	1.68	0	NA
96E1-76.2	TEU 9 Level 3	Flake Shatter	Quartzite	1	0.1	4.80	4.80	3.50	0.65	0	NA
96E1-77.2	TEU 9 Level 3	Flake Shatter	Galena	1	3.3	21.65	21.65	20.20	9.60	0	NA
96E1-78.1	TEU 9 Level 3	Flake Shatter	Galena	1	1.6	20.08	17.95	12.62	6.14	0	NA
96E1-78.2	TEU 9 Level 3	Flake Shatter	Galena	1	0.3	11.58	9.98	10.04	3.64	0	NA

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Catalog No.	Provenience	Description	Material	No.	Wgt (g)	MLD (mm)	L (mm)	W (mm)	Th (mm)	Cortex	Platform
96E1-27.1	Locale B Surface	Proximal Flake	Unid	1	8.5	39.00	38.40	21.80	13.70	0	Complex
96E1-27.2	Locale B Surface	Proximal Flake	PDC	1	2.1	25.00	24.30	14.60	5.80	0	Complex
96E1-27.3	Locale B Surface	Proximal Flake	PDC	1	1.4	28.30	28.30	14.00	5.10	0	Complex
96E1-27.6	Locale B Surface	Proximal Flake	Unid	1	0.2	13.80	13.80	5.30	3.70	0	Abraded
96E1-27.8	Locale B Surface	Proximal Flake	Hixton	1	0.5	15.40	15.40	9.10	3.80	0	Unknown
96E1-29.2	Locale B Surface	Proximal Flake	PDC	1	0.1	9.26	8.75	9.13	2.04	0	Flat
96E1-29.4	Locale B Surface	Proximal Flake	Galena	1	0.2	14.25	13.09	7.41	2.39	0	Complex
96E1-29.7	Locale B Surface	Proximal Flake	PDC	1	0.2	12.42	11.85	7.85	2.51	0	Complex
96E1-30.2	Locale B Surface	Proximal Flake	Galena	1	0.1	6.60	5.00	4.10	2.60	0	Flat
96E1-39.1	Locale B Surface	Proximal Flake	HBL	1	0.1	11.50	9.72	6.78	1.84	0	NA
96E1-39.2	Locale B Surface	Proximal Flake	Unid	1	0.1	11.96	10.84	8.45	2.14	0	Flat
96E1-39.4	Locale B Surface	Proximal Flake	PDC	1	0.1	10.24	10.24	6.05	0.98	0	Flat
96E1-39.6	Locale B Surface	Proximal Flake	PDC	1	0.1	8.63	7.66	6.39	1.72	0	Abraded
96E1-39.7	Locale B Surface	Proximal Flake	PDC	1	0.1	8.96	8.43	5.56	1.21	0	Flat
96E1-40.12	Locale B Surface	Proximal Flake	Galena	1	0.1	5.70	5.04	5.24	0.91	0	Complex
96E1-40.15	Locale B Surface	Proximal Flake	PDC	1	0.1	2.75	2.26	1.79	0.47	0	Flat
96E1-40.19	Locale B Surface	Proximal Flake	PDC	1	0.1	6.93	6.89	3.67	0.52	0	Flat
96E1-40.5	Locale B Surface	Proximal Flake	PDC	1	0.1	6.00	4.51	5.71	0.73	0	Abraded
96E1-40.7	Locale B Surface	Proximal Flake	Unid	1	0.1	6.48	5.25	5.92	0.83	0	NA
96E1-40.8	Locale B Surface	Proximal Flake	PDC	1	0.1	6.03	5.26	5.01	1.38	0	NA
96E1-20	ST 20S 15E	Proximal Flake	PDC	1	0.1	10.71	6.87	10.57	1.32	0	Flat
96E1-66.3	TEU 1 Level 6	Proximal Flake	Galena	1	0.1	6.12	5.77	3.49	0.88	0	Complex
96E1-66.5	TEU 1 Level 6	Proximal Flake	Galena	1	0.1	6.46	5.79	6.46	1.51	0	Complex
96E1-66.6	TEU 1 Level 6	Proximal Flake	Galena	1	0.1	6.16	6.14	3.04	0.98	0	Complex
96E1-67.1	TEU 1 Level 6	Proximal Flake	Galena	1	0.1	7.14	6.38	6.94	1.18	0	Complex
96E1-67.2	TEU 1 Level 6	Proximal Flake	Galena	1	0.1	10.95	8.01	8.88	2.53	0	Cortical
96E1-67.3	TEU 1 Level 6	Proximal Flake	Galena	1	0.3	13.84	11.96	9.24	4.35	0	Flat
96E1-68.1	TEU 1 Level 6	Proximal Flake	PDC	1	0.1	7.29	5.96	6.71	2.42	3	Flat
96E1-68.2	TEU 1 Level 6	Proximal Flake	Galena	1	0.1	11.25	9.65	8.30	1.45	0	Flat
96E1-94.1	TEU 1 Level 7	Proximal Flake	Galena	1	0.1	6.05	5.45	4.32	1.00	1	Complex
96E1-94.3	TEU 1 Level 7	Proximal Flake	Galena	1	0.1	6.92	5.13	6.81	0.73	0	Complex
96E1-64	TEU 11 Level 10	Proximal Flake	Galena	1	0.1	11.21	10.68	4.75	4.03	0	Flat

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Catalog No.	Provenience	Description	Material	No.	Wgt (g)	MLD (mm)	L (mm)	W (mm)	Th (mm)	Cortex	Platform
96E1-92	TEU 11 Level 2	Proximal Flake	Unid	1	0.1	3.44	3.16	3.26	0.71	0	Abraded
96E1-74.2	TEU 11 Level 8	Proximal Flake	Quartzite	1	0.1	10.74	10.58	8.05	1.89	0	Crushed
96E1-74.3	TEU 11 Level 8	Proximal Flake	Galena	1	0.4	22.99	22.95	7.87	2.82	0	Complex
96E1-62.3	TEU 11 Level 9	Proximal Flake	Galena	1	0.1	6.75	5.85	6.23	1.15	0	Complex
96E1-747.1	TEU 12 Level 13	Proximal Flake	Unid	1	2.4	20.80	20.80	17.40	7.70	0	Complex
96E1-747.7	TEU 12 Level 13	Proximal Flake	Galena	1	0.3	13.80	12.80	10.20	2.10	0	Complex
96E1-692	TEU 12 Level 15	Proximal Flake	Unid	1	1.7	26.10	25.80	18.20	5.70	0	Complex
96E1-748	TEU 12 Level 3	Proximal Flake	PDC	1	1.1	25.20	22.40	17.80	3.20	0	Flat
96E1-749.1	TEU 12 Level 3	Proximal Flake	HBL	1	1.3	18.10	17.10	14.30	8.40	2	Cortical
96E1-749.2	TEU 12 Level 3	Proximal Flake	HBL	1	0.8	14.40	12.60	8.70	9.50	0	Complex
96E1-749.3	TEU 12 Level 3	Proximal Flake	HBL	1	0.2	9.70	8.80	6.20	3.60	0	Complex
96E1-750.13	TEU 12 Level 3	Proximal Flake	PDC	1	0.1	9.20	8.90	5.30	1.40	0	Complex
96E1-750.15	TEU 12 Level 3	Proximal Flake	PDC	1	0.1	8.20	7.80	5.20	1.10	0	Complex
96E1-750.17	TEU 12 Level 3	Proximal Flake	PDC	1	0.1	7.10	6.20	5.80	1.30	0	Complex
96E1-750.4	TEU 12 Level 3	Proximal Flake	Galena	1	0.1	11.00	9.30	6.20	2.90	1	Flat
96E1-750.5	TEU 12 Level 3	Proximal Flake	PDC	1	0.1	9.70	7.80	9.10	1.10	0	Complex
96E1-750.7	TEU 12 Level 3	Proximal Flake	PDC	1	0.1	9.30	8.10	9.00	2.70	0	Complex
96E1-750.8	TEU 12 Level 3	Proximal Flake	PDC	1	0.1	10.00	9.30	6.20	1.30	0	Complex
96E1-682.2	TEU 12 Level 4	Proximal Flake	Galena	1	0.1	7.16	6.93	5.19	0.97	0	Flat
96E1-682.3	TEU 12 Level 4	Proximal Flake	PDC	1	0.1	4.77	4.70	3.46	2.20	3	Complex
96E1-682.5	TEU 12 Level 4	Proximal Flake	PDC	1	0.1	8.37	4.13	6.52	1.41	0	Flat
96E1-682.6	TEU 12 Level 4	Proximal Flake	PDC	1	0.1	6.87	3.73	6.87	1.68	0	Complex
96E1-682.9	TEU 12 Level 4	Proximal Flake	PDC	1	0.1	6.59	6.56	5.20	0.98	0	Complex
96E1-690	TEU 12 Level 4	Proximal Flake	PDC	1	12.0	32.70	32.20	27.20	15.30	3	Crushed
96E1-712.1	TEU 12 Level 4	Proximal Flake	PDC	1	0.1	8.36	7.73	6.53	1.69	0	Abraded
96E1-712.10	TEU 12 Level 4	Proximal Flake	PDC	1	0.1	10.75	9.45	5.75	1.26	0	Abraded
96E1-712.11	TEU 12 Level 4	Proximal Flake	PDC	1	0.2	13.76	12.27	6.08	2.18	0	Complex
96E1-712.12	TEU 12 Level 4	Proximal Flake	PDC	1	0.1	11.28	10.34	6.01	1.58	0	Complex
96E1-712.13	TEU 12 Level 4	Proximal Flake	Galena	1	0.1	10.52	8.44	8.25	1.54	0	Complex
96E1-712.14	TEU 12 Level 4	Proximal Flake	Galena	1	0.1	8.62	6.57	7.76	1.27	0	Complex
96E1-712.15	TEU 12 Level 4	Proximal Flake	PDC	1	0.1	9.54	7.86	7.57	2.24	0	Crushed
96E1-712.16	TEU 12 Level 4	Proximal Flake	PDC	1	0.1	12.61	11.85	6.42	1.61	0	Complex

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Catalog No.	Provenience	Description	Material	No.	Wgt (g)	MLD (mm)	L (mm)	W (mm)	Th (mm)	Cortex	Platform
96E1-712.18	TEU 12 Level 4	Proximal Flake	PDC	1	0.1	10.89	5.23	10.84	1.18	0	Abraded
96E1-712.19	TEU 12 Level 4	Proximal Flake	PDC	1	0.1	8.62	6.43	8.42	1.12	0	Abraded
96E1-712.2	TEU 12 Level 4	Proximal Flake	Galena	1	0.2	13.75	9.43	13.63	1.81	0	Complex
96E1-712.3	TEU 12 Level 4	Proximal Flake	PDC	1	0.2	9.92	7.81	9.90	2.42	0	Complex
96E1-712.5	TEU 12 Level 4	Proximal Flake	HBL	1	0.1	10.75	9.83	7.32	1.18	0	Complex
96E1-712.9	TEU 12 Level 4	Proximal Flake	PDC	1	0.1	12.91	9.63	12.74	1.23	0	Abraded
96E1-713.1	TEU 12 Level 4	Proximal Flake	PDC	1	0.1	3.55	3.01	2.19	0.83	0	Flat
96E1-713.13	TEU 12 Level 4	Proximal Flake	PDC	1	0.3	16.41	16.20	8.64	3.68	1	Crushed
96E1-713.3	TEU 12 Level 4	Proximal Flake	Galena	1	0.4	16.45	13.75	13.51	3.23	0	Flat
96E1-713.5	TEU 12 Level 4	Proximal Flake	Galena	1	0.8	19.77	14.46	17.92	4.86	0	Crushed
96E1-718	TEU 12 Level 4	Proximal Flake	PDC	1	0.4	16.80	16.79	10.62	3.64	3	Complex
96E1-719.1	TEU 12 Level 4	Proximal Flake	PDC	1	0.1	10.77	10.00	6.20	0.84	0	Abraded
96E1-719.2	TEU 12 Level 4	Proximal Flake	PDC	1	0.1	9.53	9.50	7.77	1.66	0	Flat
96E1-719.4	TEU 12 Level 4	Proximal Flake	PDC	1	0.9	21.64	21.51	15.73	2.83	0	Complex
96E1-725	TEU 12 Level 4	Proximal Flake	Galena	1	2.0	22.00	22.00	19.30	5.80	0	Complex
96E1-651.1	TEU 12 Level 5	Proximal Flake	HBL	1	0.1	6.74	5.88	6.74	1.68	0	Flat
96E1-668.3	TEU 12 Level 5	Proximal Flake	PDC	1	0.7	18.57	12.27	15.67	3.13	0	Abraded
96E1-668.8	TEU 12 Level 5	Proximal Flake	PDC	1	0.1	9.30	8.09	6.12	1.06	0	Flat
96E1-691.1	TEU 12 Level 5	Proximal Flake	Unid	1	0.6	12.40	12.40	12.00	4.50	0	Complex
96E1-693.1	TEU 12 Level 5	Proximal Flake	Galena	1	0.4	16.00	16.00	9.40	3.80	0	Flat
96E1-649	TEU 12 Level 6	Proximal Flake	Galena	1	0.4	22.39	22.28	13.55	2.04	0	Flat
96E1-667	TEU 12 Level 6	Proximal Flake	Unid	1	0.1	8.19	8.07	7.16	0.84	0	Flat
96E1-676	TEU 12 Level 6	Proximal Flake	PDC	1	0.1	9.15	7.32	8.43	1.37	0	Flat
96E1-678	TEU 12 Level 6	Proximal Flake	Galena	1	0.1	7.92	6.60	7.07	1.24	0	Complex
96E1-686	TEU 12 Level 7	Proximal Flake	Galena	1	0.1	11.23	10.85	10.03	1.70	0	Flat
96E1-687.1	TEU 12 Level 7	Proximal Flake	Galena	1	0.1	10.55	6.80	10.55	1.90	0	Complex
96E1-571	TEU 13 Level 4	Proximal Flake	Quartz	1	0.3	13.01	10.33	11.32	2.68	0	Abraded
96E1-636	TEU 13 Level 4	Proximal Flake	PDC	1	0.1	5.90	5.90	4.30	1.30	0	Complex
96E1-640	TEU 13 Level 5	Proximal Flake	Sandstone	1	7.4	40.00	36.60	28.70	7.10	0	Complex
96E1-642.1	TEU 13 Level 5	Proximal Flake	PDC	1	0.2	12.60	11.80	7.80	2.00	0	Complex
96E1-566.1	TEU 13 Level 7	Proximal Flake	PDC	1	0.1	9.88	8.25	9.92	1.94	0	Flat
96E1-611	TEU 14 Level 10	Proximal Flake	PDC	1	4.9	36.00	36.00	22.50	7.70	0	Complex

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Catalog No.	Provenience	Description	Material	No.	Wgt (g)	MLD (mm)	L (mm)	W (mm)	Th (mm)	Cortex	Platform
96E1-608.8	TEU 14 Level 5	Proximal Flake	PDC	1	0.7	17.31	11.98	15.36	3.84	0	Complex
96E1-528	TEU 14 Level 7	Proximal Flake	PDC	1	0.8	19.50	19.20	11.50	5.90	0	Flat
96E1-551.1	TEU 14 Level 7	Proximal Flake	Quartzite	1	0.8	14.90	11.80	9.10	6.70	0	Abraded
96E1-551.2	TEU 14 Level 7	Proximal Flake	Quartzite	1	0.5	11.20	9.30	8.00	5.90	0	Complex
96E1-751.1	TEU 14 Level 8	Proximal Flake	Basalt	1	0.2	10.63	9.16	9.85	2.11	0	Flat
96E1-751.4	TEU 14 Level 8	Proximal Flake	Basalt	1	2.9	31.10	29.04	13.22	7.86	0	Flat
96E1-753.7	TEU 14 Level 8	Proximal Flake	Quartz	1	0.1	10.29	10.25	5.93	3.29	0	Flat
96E1-754	TEU 14 Level 8	Proximal Flake	Quartz	1	0.1	8.04	7.55	6.33	1.83	0	Flat
96E1-755.1	TEU 14 Level 8	Proximal Flake	PDC	1	0.1	4.70	4.13	3.07	0.74	0	Flat
96E1-755.3	TEU 14 Level 8	Proximal Flake	Galena	1	0.1	4.83	4.51	3.79	0.91	0	Flat
96E1-757	TEU 14 Level 8	Proximal Flake	Unid	1	2.6	25.80	25.80	18.20	7.60	0	Complex
96E1-769	TEU 14 Level 8	Proximal Flake	PDC	1	0.3	17.10	16.80	12.00	1.50	0	Complex
96E1-770	TEU 14 Level 8	Proximal Flake	PDC	1	0.4	18.30	17.90	8.50	4.00	0	Flat
96E1-553	TEU 14 Level 9	Proximal Flake	Quartzite	1	0.4	13.70	10.40	9.50	4.80	0	Complex
96E1-569	TEU 14 Level 9	Proximal Flake	Basalt	1	0.3	12.72	12.14	8.64	2.78	0	Flat
96E1-732.1	TEU 15 Level 3	Proximal Flake	PDC	1	0.1	2.25	1.68	2.23	0.29	0	Flat
96E1-739.1	TEU 15 Level 3	Proximal Flake	PDC	1	2.6	22.70	17.60	23.20	15.40	0	Abraded
96E1-659.14	TEU 15 Level 4	Proximal Flake	PDC	1	0.1	7.66	5.94	7.58	0.90	0	Shattered
96E1-659.19	TEU 15 Level 4	Proximal Flake	PDC	1	0.1	6.02	5.85	4.01	1.73	1	Cortical
96E1-659.25	TEU 15 Level 4	Proximal Flake	PDC	1	0.1	4.67	4.13	4.63	1.26	0	Flat
96E1-659.4	TEU 15 Level 4	Proximal Flake	PDC	1	0.1	6.37	5.47	5.34	1.71	0	Flat
96E1-660.12	TEU 15 Level 4	Proximal Flake	PDC	1	0.1	10.78	10.78	7.34	1.63	0	Complex
96E1-660.4	TEU 15 Level 4	Proximal Flake	Galena	1	0.1	9.45	9.32	5.76	0.92	0	Complex
96E1-662.2	TEU 15 Level 4	Proximal Flake	PDC	1	0.2	13.24	12.19	9.85	2.66	0	Flat
96E1-664	TEU 15 Level 4	Proximal Flake	PDC	1	0.2	11.95	11.61	7.73	2.61	0	Complex
96E1-717	TEU 15 Level 5	Proximal Flake	Galena	1	0.7	22.10	22.00	14.10	3.00	0	Complex
96E1-759.10	TEU 15 Level 5	Proximal Flake	PDC	1	0.1	5.86	3.01	5.83	0.78	0	Complex
96E1-759.15	TEU 15 Level 5	Proximal Flake	PDC	1	0.1	4.22	3.26	4.22	1.42	0	Flat
96E1-759.3	TEU 15 Level 5	Proximal Flake	PDC	1	0.1	6.66	5.31	4.12	1.45	0	Complex
96E1-759.5	TEU 15 Level 5	Proximal Flake	PDC	1	0.1	5.97	4.57	5.84	0.92	0	Flat
96E1-761	TEU 15 Level 5	Proximal Flake	PDC	1	3.1	27.40	27.40	14.50	9.30	0	Complex
96E1-765	TEU 15 Level 5	Proximal Flake	PDC	1	0.3	16.31	16.09	8.66	2.66	0	Complex

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Catalog No.	Provenience	Description	Material	No.	Wgt (g)	MLD (mm)	L (mm)	W (mm)	Th (mm)	Cortex	Platform
96E1-766.4	TEU 15 Level 5	Proximal Flake	PDC	1	0.2	14.26	14.24	5.59	2.88	0	NA
96E1-766.5	TEU 15 Level 5	Proximal Flake	PDC	1	0.3	13.86	9.35	12.05	2.97	0	Complex
91E1-646.2	TEU 15 Level 6	Proximal Flake	PDC	1	0.7	17.71	16.99	8.89	4.96	1	Cortextual
96E1-620.2	TEU 15 Level 6	Proximal Flake	PDC	1	0.1	6.65	6.60	4.52	1.03	0	Flat
96E1-620.5	TEU 15 Level 6	Proximal Flake	Galena	1	0.1	5.99	4.68	5.91	1.42	0	Abraded
96E1-620.9	TEU 15 Level 6	Proximal Flake	PDC	1	0.1	6.40	6.40	3.70	1.39	0	Complex
96E1-645.1	TEU 15 Level 6	Proximal Flake	PDC	1	0.3	14.05	13.36	10.50	2.57	0	Crushed
96E1-645.4	TEU 15 Level 6	Proximal Flake	PDC	1	0.3	15.23	9.34	14.98	2.15	0	Flat
96E1-645.5	TEU 15 Level 6	Proximal Flake	Galena	1	0.1	8.50	5.82	8.45	1.22	0	Flat
96E1-645.7	TEU 15 Level 6	Proximal Flake	PDC	1	0.1	10.77	9.92	8.61	1.74	0	Abraded
96E1-703.1	TEU 15 Level 7	Proximal Flake	Galena	1	0.1	7.00	7.00	5.10	1.40	0	Complex
96E1-704	TEU 15 Level 7	Proximal Flake	Galena	1	1.7	24.50	22.80	10.40	7.30	0	Complex
96E1-706.1	TEU 15 Level 7	Proximal Flake	Quartzite	1	4.2	34.30	31.20	15.80	6.80	0	Complex
96E1-707.2	TEU 15 Level 7	Proximal Flake	Unid	1	0.1	7.20	7.20	4.10	1.70	0	Flat
96E1-707.3	TEU 15 Level 7	Proximal Flake	Unid	1	0.1	7.80	7.80	4.00	2.30	0	Flat
96E1-710.1	TEU 15 Level 7	Proximal Flake	PDC	1	0.1	7.73	7.32	5.31	1.38	0	Flat
96E1-710.2	TEU 15 Level 7	Proximal Flake	Galena	1	0.1	9.88	9.83	7.36	1.34	0	Flat
96E1-711	TEU 15 Level 7	Proximal Flake	PDC	1	2.0	26.03	25.96	14.15	7.97	0	Complex
96E1-722	TEU 15 Level 7	Proximal Flake	Galena	1	4.0	29.10	26.80	23.00	6.50	0	Complex
96E1-560	TEU 15 Level 9	Proximal Flake	Basalt	1	2.1	28.10	28.10	15.00	7.00	0	Flat
96E1-694	TEU 16 Level 6	Proximal Flake	Galena	1	0.3	15.01	14.41	8.26	2.73	0	Flat
96E1-726.1	TEU 17 Level 7	Proximal Flake	PDC	1	0.1	7.19	7.19	3.22	1.09	0	Complex
96E1-726.3	TEU 17 Level 7	Proximal Flake	PDC	1	0.1	6.99	5.10	6.13	0.91	0	Complex
96E1-733	TEU 17 Level 7	Proximal Flake	Galena	1	1.6	24.60	22.00	19.10	4.00	0	Complex
96E1-654	TEU 19 Level 4	Proximal Flake	Galena	1	0.1	8.29	7.41	4.94	1.15	0	Flat
96E1-71	TEU 2 Level ?	Proximal Flake	PDC	1	0.1	8.62	7.84	7.05	1.73	0	Abraded
96E1-623	TEU 20 Level 2	Proximal Flake	PDC	1	0.4	15.50	13.10	13.10	2.20	0	Abraded
96E1-624.2	TEU 20 Level 4	Proximal Flake	Galena	1	0.1	8.18	7.10	8.16	1.54	0	Flat
96E1-625.2	TEU 20 Level 4	Proximal Flake	PDC	1	0.2	18.20	17.77	8.93	1.40	0	NA
96E1-684	TEU 22 Level 2	Proximal Flake	PDC	1	0.1	8.54	7.56	4.47	0.94	0	Abraded
96E1-158	TEU 4 Level 4	Proximal Flake	Hixton	1	3.8	35.00	34.40	14.90	6.80	0	Complex
96E1-159	TEU 4 Level 4	Proximal Flake	PDC	1	0.6	20.80	15.10	14.20	3.30	0	Flat

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Catalog No.	Provenience	Description	Material	No.	Wgt (g)	MLD (mm)	L (mm)	W (mm)	Th (mm)	Cortex	Platform
96E1-139	TEU 4 Level 5	Proximal Flake	Galena	1	1.3	21.00	21.00	13.00	5.20	0	Flat
96E1-211	TEU 4 Level 6	Proximal Flake	Quartz	1	4.5	30.80	30.20	21.90	7.70	0	Flat
96E1-83.3	TEU 4 Level 7	Proximal Flake	Galena	1	0.1	6.69	6.10	4.77	1.93	1	Unknown
96E1-84.2	TEU 4 Level 7	Proximal Flake	Galena	1	1.7	20.93	20.22	20.93	7.14	0	Flat
96E1-85.1	TEU 4 Level 7	Proximal Flake	Galena	1	0.2	10.15	19.96	9.87	2.08	0	Complex
96E1-85.10	TEU 4 Level 7	Proximal Flake	Galena	1	0.1	7.51	7.47	6.24	1.49	0	Flat
96E1-85.11	TEU 4 Level 7	Proximal Flake	Galena	1	0.1	8.20	7.82	6.10	0.86	0	Abraded
96E1-85.2	TEU 4 Level 7	Proximal Flake	PDC	1	0.1	10.14	9.46	5.80	1.18	0	Flat
96E1-85.3	TEU 4 Level 7	Proximal Flake	PDC	1	0.1	13.96	13.77	7.83	1.43	0	Flat
96E1-85.4	TEU 4 Level 7	Proximal Flake	Unid	1	0.1	10.48	7.33	8.68	1.74	0	Abraded
96E1-85.5	TEU 4 Level 7	Proximal Flake	PDC	1	0.3	14.18	9.91	12.64	2.21	0	Complex
96E1-85.6	TEU 4 Level 7	Proximal Flake	PDC	1	0.1	8.37	6.94	8.36	1.35	0	Complex
96E1-85.7	TEU 4 Level 7	Proximal Flake	Galena	1	0.1	9.49	8.64	7.20	1.49	0	Flat
96E1-85.9	TEU 4 Level 7	Proximal Flake	PDC	1	0.1	6.59	5.98	4.46	1.54	0	Complex
96E1-86.4	TEU 4 Level 7	Proximal Flake	PDC	1	0.1	10.48	6.85	10.42	1.21	0	Flat
96E1-89	TEU 4 Level 7	Proximal Flake	Galena	1	0.6	17.40	17.40	12.60	3.00	0	Flat
96E1-90	TEU 4 Level 7	Proximal Flake	Quartzite	1	0.4	12.90	11.60	9.40	3.30	0	Abraded
96E1-98.1	TEU 4 Level 7	Proximal Flake	PDC	1	0.1	6.24	4.78	6.12	2.17	0	Abraded
96E1-238	TEU 4 Level 8	Proximal Flake	PDC	1	0.2	10.60	10.60	7.20	3.00	0	Flat
96E1-73	TEU 5 Level 9	Proximal Flake	Galena	1	1.0	19.30	18.20	13.10	5.20	1	Cortical
96E1-133	TEU 8 Level 4	Proximal Flake	Galena	1	9.6	39.30	39.30	29.80	12.00	0	Complex
96E1-81	TEU 8 Level 9	Proximal Flake	Galena	1	0.6	17.20	16.80	8.80	4.90	0	Complex
96E1-75.1	TEU 9 Level 3	Proximal Flake	Galena	1	0.2	12.75	11.90	9.40	1.90	0	Complex
96E1-75.2	TEU 9 Level 3	Proximal Flake	Galena	1	0.1	9.25	8.57	8.00	8.60	0	Complex
96E1-75.3	TEU 9 Level 3	Proximal Flake	Galena	1	0.1	11.00	10.90	7.82	1.50	0	Flat
96E1-76.1	TEU 9 Level 3	Proximal Flake	Quartzite	1	0.1	7.78	7.49	6.10	1.75	0	Flat
96E1-77.1	TEU 9 Level 3	Proximal Flake	Galena	1	1.9	25.78	25.00	21.36	4.05	0	Complex
96E1-695	TEU 12 Level 7	Bead	Copper	1	4.4	NA	18.8	11.0	6.1	NA	NA
96E1-612	TEU 14 Level 7	Bead	Copper	1	0.1	NA	4.2	4.9	3.0	NA	NA
96E1-723	TEU 14 Level 7	Bead	Copper	1	0.1	NA	9.5	9.5	2.8	NA	NA
96E1-292	TEU 4 Level 8	Bead Blank?	Copper	1	0.3	NA	41.2	2.4	1.0	NA	NA
96E1-269	Surface	Bipointed	Copper	1	0.3	NA	19.4	3.6	2.1	NA	NA

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Catalog No.	Provenience	Description	Material	No.	Wgt (g)	MLD (mm)	L (mm)	W (mm)	Th (mm)	Cortex	Platform
96E1-305	TEU 10 Level 5	Bipointed	Copper	1	0.5	NA	22.0	2.9	2.9	NA	NA
96E1-604	TEU 14 Level 5	Bipointed	Copper	1	1.0	NA	20.0	3.9	3.9	NA	NA
96E1-287	TEU 4 Level 7	Bipointed	Copper	1	1.5	NA	33.0	3.5	2.6	NA	NA
96E1-288	TEU 4 Level 7	Bipointed	Copper	1	0.1	NA	8.1	2.8	2.0	NA	NA
96E1-263	STU 6	Edged Preform	Copper	1	9.4	NA	68.2	11.9	3.8	NA	NA
96E1-251	Surface	Edged Preform	Copper	1	11.5	NA	44.7	15.5	3.9	NA	NA
96E1-291	STU 4	Point Preform	Copper	1	14.0	NA	46.9	16.2	6.2	NA	NA
96E1-548	TEU 14 Level 4	Point Preform	Copper	1	10.1	NA	60.5	13.4	4.1	NA	NA
96E1-653	TEU 14 Level 5	Point Preform	Copper	1	7.6	NA	39.5	11.2	4.4	NA	NA
96E1-280	TEU 4 Level 5	Point Preform	Copper	1	7.1	NA	30.2	11.4	4.5	NA	NA
96E1-281	STU 4	Scrap	Copper	1	0.1	NA	7.4	5.0	1.2	NA	NA
96E1-281	STU 4	Scrap	Copper	1	0.1	NA	3.3	1.7	1.0	NA	NA
96E1-742	TEU 15 Level 6	Scrap	Copper	1		NA				NA	NA
96E1-742	TEU 15 Level 6	Scrap	Copper	1	0.1	NA				NA	NA
96E1-742	TEU 15 Level 6	Scrap	Copper	1	0.1	NA				NA	NA
96E1-742	TEU 15 Level 6	Scrap	Copper	1	0.1	NA	1.2	1.1	0.5	NA	NA
96E1-742	TEU 15 Level 6	Scrap	Copper	1	0.1	NA	0.9	0.5	0.5	NA	NA
96E1-306	TEU 4 Level 6	Scrap	Copper	1	1.7	NA				NA	NA
96E1-728	TEU 12 Level 5	Shaped	Copper	1	185.4	NA	60.1	41.9	14.4	NA	NA
96E1-257		Shaped	Copper	1	52.4	NA	53.8	19.1	10.2	NA	NA
96E1-265	STU 13	Unworked	Copper	1	1.0	NA	13.5	7.4	3.4	NA	NA
96E1-260	STU 15	Unworked	Copper	1	3.7	NA				NA	NA
96E1-255	STU 3	Unworked	Copper	1	7.6	NA				NA	NA
96E1-252	STU 7	Unworked	Copper	1	3.3	NA				NA	NA
96E1-268	Surface	Unworked	Copper	1	1.8	NA				NA	NA
96E1-300	Surface	Unworked	Copper	1	1.9	NA	18.1	6.1	4.3	NA	NA
96E1-301	Surface	Unworked	Copper	1	3.4	NA				NA	NA
96E1-293	TEU 12	Unworked	Copper	1	0.2	NA	6.8	5.0	3.9	NA	NA
96E1-702	TEU 14 Level 8	Unworked	Copper	1	0.9	NA	12.0	8.0	6.0	NA	NA
96E1-729	TEU 15 Level 5	Unworked	Copper	1	2.0	NA				NA	NA
96E1-513	TEU 22 Level 4	Unworked	Copper	1	4.1	NA		16.8	8.2	NA	NA
96E1-276	TEU 4 Level 7	Unworked	Copper	1	0.8	NA	10.0	7.0	5.0	NA	NA

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96E1-310	TEU 4 Level 8	Unworked	Copper	1	0.2	NA				NA	NA
96E1-317	TEU 4 Level 8	Unworked	Copper	1	0.5	NA				NA	NA
96E1-273	TEU 4 Level 9	Unworked	Copper	1	1.1	NA	17.0	9.0	4.0	NA	NA
96E1-290	TEU 4 Level 9	Unworked	Copper	5	3.5	NA				NA	NA
96E1-282		Unworked	Copper	1	1.5	NA	10.7	8.9	4.7	NA	NA
96E1-309	50S 0E	Worked	Copper	1	0.9	NA	7.4	4.2	4.2	NA	NA
96E1-60	55S 50E	Worked	Copper	1	0.7	NA			1.0	NA	NA
96E1-523	STU 1	Worked	Copper	1	4.6	NA	27.0	11.0	6.5	NA	NA
96E1-299	STU 14	Worked	Copper	1	2.0	NA	14.0	7.5	5.5	NA	NA
96E1-307	STU 16	Worked	Copper	1	1.3	NA				NA	NA
96E1-264	STU 20	Worked	Copper	1	2.5	NA	21.2	11.4	4.2	NA	NA
96E1-303	STU 22	Worked	Copper	1	4.9	NA	22.0	12.0	6.4	NA	NA
96E1-308	STU 23	Worked	Copper	1	16.3	NA	29.5	20.0	11.5	NA	NA
96E1-283	STU 3	Worked	Copper	1	5.6	NA	22.7	16.3	6.2	NA	NA
96E1-313	STU 8	Worked	Copper	1	3.2	NA	15.4	14.1	6.0	NA	NA
96E1-271	Surface	Worked	Copper	1	0.8	NA	15.4	8.9	2.5	NA	NA
96E1-272	Surface	Worked	Copper	1	5.2	NA	19.1	12.8	4.9	NA	NA
96E1-275	Surface	Worked	Copper	1	1.1	NA	13.7	8.0	3.0	NA	NA
96E1-278	Surface	Worked	Copper	1	2.0	NA	13.3	10.5	3.5	NA	NA
96E1-289	Surface	Worked	Copper	1	0.5	NA				NA	NA
96E1-294	Surface	Worked	Copper	1	1.7	NA	11.5	8.6	6.1	NA	NA
96E1-261	TEU 1 Level 6	Worked	Copper	1	1.4	NA				NA	NA
96E1-256	TEU 10 Level 5	Worked	Copper	1	9.4	NA	23.3	13.6	5.8	NA	NA
96E1-274	TEU 11	Worked	Copper	1	18.6	NA	27.2	23.7	10.5	NA	NA
96E1-277	TEU 11 Level 8	Worked	Copper	1	6.7	NA	25.6	14.0	6.5	NA	NA
96E1-724	TEU 12 Level 4	Worked	Copper	1	35.7	NA	32.4	29.8	8.0	NA	NA
96E1-744	TEU 12 Level 5	Worked	Copper	1	6.7	NA	22.5	21.5	9.4	NA	NA
96E1-254	TEU 13 Level 1	Worked	Copper	1	2.4	NA	14.9	12.0	4.2	NA	NA
96E1-617	TEU 14 Level 6	Worked	Copper	1	9.6	NA	34.9	23.5	3.3	NA	NA
96E1-578	TEU 17 Level 5	Worked	Copper	1	6.0	NA	26.4	11.8	9.2	NA	NA
96E1-577	TEU 17 Level 6	Worked	Copper	1	6.6	NA	27.0	14.7	4.9	NA	NA
96E1-267	TEU 3 Level 5	Worked	Copper	1	3.1	NA	17.2	11.8	4.3	NA	NA

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Catalog No.	Provenience	Description	Material	No.	Wgt (g)	MLD (mm)	L (mm)	W (mm)	Th (mm)	Cortex	Platform
96E1-297	TEU 4	Worked	Copper	1	0.1	NA	22.5	14.4	9.9	NA	NA
96E1-284	TEU 4 Level 6	Worked	Copper	1	1.4	NA	11.7	8.5	4.1	NA	NA
96E1-315	TEU 4 Level 6	Worked	Copper	1	10.4	NA				NA	NA
96E1-319	TEU 4 Level 6	Worked	Copper	1	1.1	NA				NA	NA
96E1-286	TEU 4 Level 7	Worked	Copper	1	0.8	NA	13.4	5.5	3.6	NA	NA
96E1-285	TEU 4 Level 8	Worked	Copper	1	3.6	NA	32.0	12.1	3.0	NA	NA
96E1-311	TEU 4 Level 8	Worked	Copper	1	1.9	NA	23.2	8.4	3.0	NA	NA
96E1-314	TEU 4 Level 8	Worked	Copper	1	0.4	NA	12.0	7.0	1.5	NA	NA
96E1-325	TEU 4 Level 8	Worked	Copper	1	2.2	NA				NA	NA
96E1-316	TEU 4 Level 9	Worked	Copper	1	14.0	NA	31.0	16.0	7.0	NA	NA
96E1-262	TEU 9 Level 3	Worked	Copper	1	5.1	NA	21.0	17.0	6.0	NA	NA
96E1-		Worked	Copper	1	7.5	NA	24.8	12.5	5.9	NA	NA
96E1-		Worked	Copper	1	0.1	NA				NA	NA
96E1-		Worked	Copper	2	0.5	NA				NA	NA
96E1-562	TEU 15 Level 4	Biface	Galena	1	12.00						
96E1-48	10W 5S Surface	Biface	Unid	1	2.30						
96E1-207	TEU 10 Level 3	Biface	Unid	1	0.30						
96E1-641	TEU 14 Level 75	Biface	PDC	1	3.40						
96E1-581a	TEU 17 Level 5	Biface	Quartz	1	0.50						
96E1-110	TEU 17 Surface	Biface	KRF	1	0.40						
96E1-298	TEU 4 Level 6	Biface	PDC	1	1.90						
96E1-178	TEU 4 Level 9	Biface	Unid	1	1.40						
96E1-80	Locale C Surface	Core	PDC	1	12.50						
96E1-175	STU 23 Surface	Core	HBL	1	3.40						
96E1-690	TEU 12 Level 4	Core	HBL	1	12.20						
96E1-544	TEU 14 Level 3	Core	PDC	1	1.80						
96E1-140	TEU 4 Level 5	Core	HBL	1	6.00						
96E1-141	TEU 4 Level 5	Core	Unid	1	3.80						
96E1-117	TEU 4 Level 8	Core	HBL	1	?						
96E1-47	10W 5S Surface	Drill	PDC	1	1.00						
96E1-59	30S 25E	Drill	PDC	1	0.90						
96E1-525	TEU 14 Level 7	Drill	KRF	1	0.70						

Duck Lake Catalog

Catalog No.	Provenience	Description	Material	No.	Wgt (g)	MLD (mm)	L (mm)	W (mm)	Th (mm)	Cortex	Platform
96E1-102	TEU 1 Level 7	Point	Onondaga	1	0.60						
96E1-167	TEU 1 Level 8	Point	HBL	1	0.20						
96E1-109	TEU 17 Surface	Point	PDC	1	2.50						
96E1-88	TEU 4 Level 7	Point	PDC	1	3.20						
96E1-514	TEU 13 Level 8	Retouched Flake	Quartz	1	11.20						
96E1-762	TEU 15 Level 5	Retouched Flake	Galena	1	3.20						
96E1-196	TEU 4 Level 4	Retouched Flake	PDC	1	0.90						
96E1-221	TEU 9 Level 8	Retouched Flake	Quartz	1	1.60						
96E1-108		Retouched Flake	Quartz	1	6.90						
96E1-158		Retouched Flake	PDC	1	3.80						
96E1-192		Retouched Flake	PDC	1	2.20						
96E1-195		Retouched Flake	PDC	1	1.90						
96E1-239		Retouched Flake	PDC	1	0.80						
96E1-240		Retouched Flake	PDC	1	1.00						
96E1-36		Retouched Flake	KRF	1	1.80						
96E1-44		Retouched Flake	Quartz	1	1.80						
96E1-50		Retouched Flake	PDC	1	3.60						
96E1-528		Retouched Flake	PDC	1	0.90						
96E1-550		Retouched Flake	HBL	1	1.90						
96E1-607		Retouched Flake	HBL	1	4.90						
96E1-611		Retouched Flake	PDC	1	5.00						
96E1-717		Retouched Flake	PDC	1	0.90						
96E1-722		Retouched Flake	Galena	1	4.00						
96E1-757		Retouched Flake	Galena	1	2.80						
96E1-761		Retouched Flake	PDC	1	3.00						
96E1-81		Retouched Flake	PDC	1	0.80						
96E1-89		Retouched Flake	PDC	1	0.80						
96E1-90		Retouched Flake	Quartz	1	0.40						
96E1-97		Retouched Flake	PDC	1	2.20						
96E1-35	Locale B	Scraper	PDC	1	0.90						
96E1-58	Locale B Surface	Scraper	PDC	1	1.60						
96E1-199	STU 16 Surface	Scraper	Unid	1	2.70						

Duck Lake Catalog

Catalog No.	Provenience	Description	Material	No.	Wgt (g)	MLD (mm)	L (mm)	W (mm)	Th (mm)	Cortex	Platform
96E1-689	TEU 12 Level 4	Scraper	PDC	1	2.50						
96E1-543	TEU 14 Level 3	Scraper	PDC	1	0.70						
96E1-584	TEU 15 Level 4	Scraper	PDC	1	1.80						
96E1-601	TEU 17 Level 12	Uniface	Sandstone	1	7.90						
96E1-69	TEU 1 Level 6	Utilized Flake	Galena	1	0.30						
96E1-701	TEU 15 Level 6	Utilized Flake	Quartz	1	1.40						
96E1-581b	TEU 17 Level 5	Utilized Flake	PDC	1	3.10						
96E1-211	TEU 4 Level 6	Utilized Flake	Quartz	1	4.40						
96E1-212	TEU 6 Level 8	Utilized Flake	Unid	1	1.40						
96E1-13		Utilized Flake	PDC	1	0.80						
96E1-139		Utilized Flake	PDC	1	1.40						
96E1-144		Utilized Flake	PDC	1	0.35						
96E1-159		Utilized Flake	PDC	1	0.85						
96E1-163		Utilized Flake	Unid	1	0.60						
96E1-164		Utilized Flake	Unid	1	0.70						
96E1-2		Utilized Flake	HBL	1	0.90						
96E1-204		Utilized Flake	Galena	1	1.60						
96E1-222		Utilized Flake	PDC	1	0.70						
96E1-237		Utilized Flake	PDC	1	0.30						
96E1-238		Utilized Flake	PDC	1	0.30						
96E1-248		Utilized Flake	Unid	1	0.80						
96E1-249		Utilized Flake	Unid	1	0.40						
96E1-43		Utilized Flake	Quartz	1	3.20						
96E1-46		Utilized Flake	PDC	1	0.35						
96E1-49		Utilized Flake	PDC	1	1.20						
96E1-51		Utilized Flake	PDC	1	0.60						
96E1-52		Utilized Flake	Unid	1	0.80						
96E1-53		Utilized Flake	Unid	1	0.40						
96E1-54		Utilized Flake	Unid	1	0.05						
96E1-56		Utilized Flake	Unid	1	1.30						
96E1-57		Utilized Flake	KRF	1	1.80						
96E1-6		Utilized Flake	Galena	1	0.20						

Duck Lake Catalog

Catalog No.	Provenience	Description	Material	No.	Wgt (g)	MLD (mm)	L (mm)	W (mm)	Th (mm)	Cortex	Platform
96E1-623		Utilized Flake	PDC	1	0.50						
96E1-628		Utilized Flake	Quartz	1	0.20						
96E1-665		Utilized Flake	PDC	1	1.45						
96E1-666		Utilized Flake	Unid	1	0.50						
96E1-680		Utilized Flake	PDC	1	1.40						
96E1-692		Utilized Flake	PDC	1	1.40						
96E1-696		Utilized Flake	Quartz	1	0.80						
96E1-704		Utilized Flake	Galena	1	1.80						
96E1-705		Utilized Flake	Galena	1	0.50						
96E1-725		Utilized Flake	PDC	1	2.00						
96E1-733		Utilized Flake	Galena	1	1.70						
96E1-739		Utilized Flake	PDC	1	2.00						
96E1-739b		Utilized Flake	PDC	1	1.20						
96E1-748		Utilized Flake	PDC	1	1.10						
96E1-758		Utilized Flake	PDC	1	0.50						
96E1-763		Utilized Flake	PDC	1	0.05						
96E1-769		Utilized Flake	PDC	1	0.20						
96E1-770		Utilized Flake	PDC	1	0.20						
96E1-79		Utilized Flake	Galena	1	0.30						
96E1-93		Utilized Flake	PDC	1	0.40						
96E1-96		Utilized Flake	PDC	1	5.40						

APPENDIX VI

BURNT ROLLWAYS SITE

LITHIC TOOL CATALOG

Burnt Rollways Lithic Tools

Acc. No.	Prov		Level	Item	Count	Material	Wt (g)	L	W	Th	Stem L	Stem W	Base W	Notch W
21376	F2			Biface	1	Arg	17.3	49.39	33.92	9.34				
21376	S			Biface	1	Arg	20.0	36.78	30.50	17.25				
21376	65	24	B6	Biface	1	BP	23.7	55.83	33.99	11.61				
21376	TP7		B1	Biface	1	Ortho	1.5	16.98	17.36	6.56				
21376	F1			Biface	1	PDC	8.0	26.72	31.47	8.70				
21376	TP4		E4	Biface	1	PDC	5.0	28.62	25.58	6.13				
21376	54	38	B2	Biface	1	Q	2.4	24.09	16.25	7.00				
21376	TP4		NVC	Biface	1	Q	0.8	14.11	12.91	5.17				
21376	53	40	B3	Biface	1	Q	6.4	32.58	21.35	10.16				
21376	64	27	B2	Biface	1	Qtzt	15.1	44.75	28.68	11.48				
21376	65	6	B1	Biface	1	Unid	2.5	25.69	19.22	5.98				
21376	60	6	B5	Biface	1	Unid	0.3	17.73	5.66	3.02				
21376	65	28	B2	Drill	1	PDC	7.4	49.46	25.33	13.72				
21376	56	7	B1	Drill	1	Q	1.0	17.23	10.13	6.47				
21376	TP4		B	Endscraper	1	HBL	6.2	37.50	20.88	11.82				
21376	61	5	B3	Hafted Biface	1	Arg	5.4	37.21	20.68	8.77	11.30	13.55	13.92	7.9
21376	51	6	F1	Hafted Biface	1	Gal	1.4	18.89	14.33	6.00	8.60	9.38	12.16	5.7
2137-	?	?	E1	Hafted Biface	1	KLS	28.2	95.43	33.44	8.15	43.81	13.84	13.84	NA
21376	51	6	B2	Hafted Biface	1	On	4.1	34.59	19.05	6.36	10.80	9.35	11.63	10.7
21376	52	40	B3	Hafted Biface	1	Ortho	3.5	29.53	20.56	5.61	9.85	11.34	11.42	8.8
21376	51	5	B5	Hafted Biface	1	Ortho	2.7	17.32	24.75	5.08	7.60	12.23	15.26	5.9
21376	52	40	B2	Hafted Biface	1	PDC	7.8	54.42	21.82	6.79	15.97	11.26	13.73	11.5
21376	52	40	B2	Hafted Biface	1	PDC	7.9	54.42	21.82	6.77	14.75	11.25	13.75	12.5
21376	TP4		NVC	Hafted Biface	1	PDC	4.1	34.20	20.32	6.44	9.42	9.53	10.87	7.9
21376	TP4		I	Hafted Biface	1	PDC	4.5	32.01	21.38	7.18	10.49	10.44	12.94	7.8
21376	F1			Hafted Biface	1	PDC	3.2	34.91	20.75	5.15	9.60	8.99	12.51	8.0
21376	51	6	F1	Hafted Biface	1	PDC	1.8	22.68	17.64	5.91	8.00	9.85	13.48	7.9
21376	F1			Hafted Biface	1	PDC	2.0	22.76	17.48	5.50	8.40	8.85	11.65	7.2
21376	51	6	F1	Hafted Biface	1	PDC	1.7	22.87	16.48	4.76	7.20	8.75	11.20	6.9
21376	62	25	B3	Hafted Biface	1	PDC	1.4	21.07	16.36	6.04	11.10	9.35	12.66	6.1
21376	52	40	B2	Hafted Biface	1	PDC	4.1	40.43	22.16	6.25	13.61	14.66	14.34	11.9
21376	55	42	B1	Hafted Biface	1	PDC	1.3	13.91	15.27	5.68	10.20	11.10	12.02	8.9
21376	F1			Hafted Biface	1	PDC	1.7	17.19	15.34	6.35		8.79		

Acc. No.	Prov		Level	Item	Count	Material	Wt (g)	L	W	Th	Stem L	Stem W	Base W	Notch W
21376	64	27	B4	Hafted Biface	1	Q	6.5	29.52	21.59	9.19	11.20	16.33	18.88	6.4
21376	S			Hafted Biface	1	Q	4.2	27.05	20.77	7.29				
21376	53	39	B3	Hafted Biface	1	Q	1.0	10.70	13.62	6.95		11.43	13.60	
21376	TP5		A	Hafted Biface	1	Unid	2.1	25.45	14.02	6.01	14.00	11.25	15.05	10.3
21376	TP7		B2	Hafted Biface	1	Unid	0.2	11.46	6.20	4.43				
21376	62	24	B5	Hafted Drill	1	Maq	1.6	31.54	10.03	4.56				
21376	59	42	B2	Hafted Drill	1	Maq	1.9	27.63	10.65	6.04				
21376	S			Hafted Drill	1	Ortho	4.4	44.78	12.31	7.70				
21376	65	24	B5	Hafted Drill	1	Sil	1.6	26.48	10.55	5.52				
21376	54	38	B3	Hafted Drill	1	Sil	1.0	23.54	9.84	3.98				
21376	65	24	B3	Hafted Scraper	1	Arg	5.1	29.28	27.10	6.42	9.00	13.34	16.72	6.8
21376	F1			Retouched Flake	1	PDC	14.8	50.14	38.97	8.31				
21376	51	6	B4	Retouched Flake	1	Qtzt	11.2	40.05	34.11	7.72				
21376	60	6	B12	Spokeshave	1	HBL	3.5	21.99	16.97	6.86				
21376	51	6	B1	Utilized Flake	1	Arg	4.6	29.79	24.44	6.78				
21376	51	6	B2	Utilized Flake	1	Arg	3.4	38.74	17.12	6.34				
21376	F1			Utilized Flake	1	Bas	19.9	65.43	24.44	11.31				
21376	53	40	B3	Utilized Flake	1	Bur	1.6	40.22	16.30	2.70				
21376	S			Utilized Flake	1	HBL	1.8	25.21	13.78	8.08				
21376	TP7		B2	Utilized Flake	1	PDC	5.3	38.93	24.27	6.92				
21376	S			Utilized Flake	1	PDC	0.4	24.76	9.31	2.03				
21376	TP4		B	Utilized Flake	1	PDC	1.2	18.39	17.44	3.15				
21376	TP4		B	Utilized Flake	1	PDC	0.5	18.57	15.08	1.78				
21376	F1			Utilized Flake	1	PDC	1.4	23.72	18.88	2.94				
21376	51	6	B1	Utilized Flake	1	PDC	3.1	38.17	20.87	4.31				
21376	60	6	B5	Utilized Flake	1	PDC	0.5	18.03	8.29	3.59				
21376	51	5	B5	Utilized Flake	1	PDC	1.0	23.23	13.15	3.90				
21376	51	6	B3	Utilized Flake	1	PDC	0.7	20.10	17.17	2.83				
21376	TP4		E4	Utilized Flake	1	PDC	0.7	18.49	14.27	2.58				
21376	TP3		B	Utilized Flake	1	Q	3.0	34.66	17.42	5.13				
21376	TP7		B2	Utilized Flake	1	Q	0.3	10.97	9.61	2.68				
21376	TP4		NVC	Utilized Flake	1	Q	0.5	12.01	13.54	2.89				
21376	S			Utilized Flake	1	Q	13.0	38.04	31.46	9.30				
21376	51	5	B6	Utilized Flake	1	Q	14.1	30.95	36.65	9.30				

Acc. No.	Prov		Level	Item	Count	Material	Wt (g)	L	W	Th	Stem L	Stem W	Base W	Notch W
21376	63	27	B4	Utilized Flake	1	Q	7.1	27.19	25.27	10.54				
21376	62	25	B4	Utilized Flake	1	Q	3.3	21.07	22.69	7.44				
21376	52	6	B2	Utilized Flake	1	Q	3.2	21.33	23.55	7.20				
21376	66	29	B	Utilized Flake	1	Q	11.6	42.41	25.02	14.67				
21376	F1			Utilized Flake	1	Unid	0.6	28.32	12.51	2.19				
21376	TP4		B	Utilized Flake	1	Unid	0.5	12.84	10.96	2.89				
21376	51	5	B3	Utilized Flake	1	Unid	1.1	25.00	11.85	4.08				
21376	51	6	B1	Utilized Flake	1	Unid	2.8	26.35	25.35	5.77				
21376	53	6	B1	Utilized Flake	1	Unid	1.9	21.06	15.06	6.69				
21376	S			Wedge	1	Coc	3.4	16.46	18.22	9.99				

Material	Arg	Argilite
	Bas	Basalt
	BP	Barron County Pipestone
	Bur	Burlington Chert
	Coc	Cochrane Chert
	Gal	Galena Chert
	HBL	Hudson Bay Lowland Chert
	JT	Jasper Taconite
	KLS	Knife Lake Siltstone
	KRF	Knife River Flint
	Maq	Maquoketa Chert
	On	Onondaga Chert
	PDC	Prairie du Chien Chert
	Q	Quartz
	Qtzt	Quartzite
	Rhy	Rhyolite
	Sil	Silurian

APPENDIX VII

COPPER TRACE ELEMENT DATA

Copper Trace Element Data: Sample Descriptions

Sample No.	samp_type	Site/Source	Age	Association	State/Province	County	Description
51.6B1	Artifact	Burnt Rollways	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Unworked copper nugget
51.6B1	Artifact	Burnt Rollways	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Unworked copper nugget
56.7B1	Artifact	Burnt Rollways	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
56.7B1	Artifact	Burnt Rollways	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
59.07B4	Artifact	Burnt Rollways	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
59.07B4	Artifact	Burnt Rollways	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
62.25B5	Artifact	Burnt Rollways	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
62.25B5	Artifact	Burnt Rollways	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
63.6B4	Artifact	Burnt Rollways	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
63.6B4	Artifact	Burnt Rollways	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
63.6B4	Artifact	Burnt Rollways	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
65.26B4	Artifact	Burnt Rollways	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
66.29B2	Artifact	Burnt Rollways	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Copper scrap
66.29B2	Artifact	Burnt Rollways	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Copper scrap
TP10B1	Artifact	Burnt Rollways	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
TP10B1	Artifact	Burnt Rollways	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
96E1.254	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Worked copper nugget
96E1.254	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Worked copper nugget
96E1.255	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Unworked copper nugget
96E1.265	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Unworked copper nugget
96E1.265	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Unworked copper nugget
96E1.271	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Worked copper nugget
96E1.271	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Worked copper nugget
96E1.278	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Worked copper nugget
96E1.286	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Worked copper nugget
96E1.286	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Worked copper nugget
96E1.290	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Unworked copper nugget
96E1.294	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Worked copper nugget
96E1.294	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Worked copper nugget
96E1.305	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Bipoint
96E1.305	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Bipoint

Copper Trace Element Data: Sample Descriptions

Sample No.	samp_type	Site/Source	Age	Association	State/Province	County	Description
96E1.309	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Worked copper nugget
96E1.316	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Worked copper nugget
96E1.316	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Worked copper nugget
96E1.318	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Copper scrap
96E1.513	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Unworked copper nugget
96E1.523	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Worked copper nugget
96E1.523	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Worked copper nugget
96E1.60	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Worked copper nugget
96E1.618	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Copper scrap
96E1.653	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Point Preform
96E1.653	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Point Preform
96E1.695	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Bead
96E1.695	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Bead
96E1.702	Artifact	Duck Lake	Late Archaic	Burnt Rollways Phase	Michigan	Ontonagon	Unworked copper nugget
Unit B	Artifact	Rainbow Dam East	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Knife
Unit B	Artifact	Rainbow Dam East	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Knife
1743.108	Artifact	Rainbow Dam West	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
1743.108	Artifact	Rainbow Dam West	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
1748.18	Artifact	Rainbow Dam West	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
1748.18	Artifact	Rainbow Dam West	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
1749.55	Artifact	Rainbow Dam West	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
1749.55	Artifact	Rainbow Dam West	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
1749.56	Artifact	Rainbow Dam West	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Knife
1749.56	Artifact	Rainbow Dam West	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Knife
1751.42	Artifact	Rainbow Dam West	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
1751.42	Artifact	Rainbow Dam West	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
1744.147A	Artifact	Rainbow Dam West	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
1744.147A	Artifact	Rainbow Dam West	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
1744.147B	Artifact	Rainbow Dam West	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
1744.147B	Artifact	Rainbow Dam West	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
1744.147C	Artifact	Rainbow Dam West	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
1744.147C	Artifact	Rainbow Dam West	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget

Copper Trace Element Data: Sample Descriptions

Sample No.	samp_type	Site/Source	Age	Association	State/Province	County	Description
1744.147D	Artifact	Rainbow Dam West	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
1744.147D	Artifact	Rainbow Dam West	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
1744.147E	Artifact	Rainbow Dam West	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
1744.147E	Artifact	Rainbow Dam West	Late Archaic	Burnt Rollways Phase	Wisconsin	Oneida	Worked copper nugget
RghB13A	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Globular Bead
RghB13A	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Globular Bead
RghB13A	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Globular Bead
RghB13B	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Globular Bead
RghB13B	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Globular Bead
RghB13C	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Globular Bead
RghB13C	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Globular Bead
RghB13D	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Globular Bead
RghB13D	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Globular Bead
RghB13E	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Globular Bead
RghB13E	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Globular Bead
RghB13F	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Globular Bead
RghB13F	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Globular Bead
RghB13G	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Globular Bead
RghB13G	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Globular Bead
RghB13H	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Globular Bead
RghB13H	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Globular Bead
RghB13I	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Globular Bead
RghB13I	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Globular Bead
RghB13J	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Globular Bead
RghB13J	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Globular Bead

Copper Trace Element Data: Sample Descriptions

Sample No.	samp_type	Site/Source	Age	Association	State/Province	County	Description
RghB13K	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Globular Bead
RghB13K	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Globular Bead
RghB13L	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Globular Bead
RghB13L	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Globular Bead
RghB13L	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Globular Bead
RghB18	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Conical Point
RghB18	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Conical Point
RghB23	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Conical Point
RghB23	Artifact	Reigh	Middle Archaic	Old Copper Reigh Phase	Wisconsin	Winnebago	Conical Point
RvF13A	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF13A	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF13B	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF13B	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF13C	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF13C	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF13D	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF13D	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF13E	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF13E	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF13F	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF13F	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF13H	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF13H	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF13I	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF13I	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF13J	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF13J	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF13K	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF13K	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead

Copper Trace Element Data: Sample Descriptions

Sample No.	samp_type	Site/Source	Age	Association	State/Province	County	Description
RvF17A	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF17A	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF17B	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF17B	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF17C	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF17C	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF17D	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF17D	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF17E	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF17E	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF17F	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF17F	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF17G	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF17G	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF1G	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF1G	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF27	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Awl
RvF27	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Awl
RvF29A	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Bead
RvF29A	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Bead
RvF29B	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Bead
RvF29B	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Bead
RvF37A	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37A	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37A	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37B	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37B	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37C	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37C	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37D	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37D	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37D	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37E	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead

Copper Trace Element Data: Sample Descriptions

Sample No.	samp_type	Site/Source	Age	Association	State/Province	County	Description
RvF37E	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37F	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37F	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37G	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37G	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37H	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37H	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37I	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37I	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37J	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37J	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37K	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37K	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37L	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37L	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37L	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37M	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37M	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37N	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37N	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF37N	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Globular Bead
RvF43	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
RvF43	Artifact	Riverside	Late Archaic	Red Ocher	Michigan	Menominee	Tubular Bead
Th50787	Artifact	Thiensville	Late Archaic	Red Ocher	Wisconsin	Ozaukee	Bead
Th50787	Artifact	Thiensville	Late Archaic	Red Ocher	Wisconsin	Ozaukee	Bead
Th50790A	Artifact	Thiensville	Late Archaic	Red Ocher	Wisconsin	Ozaukee	Bead
Th50790A	Artifact	Thiensville	Late Archaic	Red Ocher	Wisconsin	Ozaukee	Bead
Th50790B	Artifact	Thiensville	Late Archaic	Red Ocher	Wisconsin	Ozaukee	Bead
Th50790B	Artifact	Thiensville	Late Archaic	Red Ocher	Wisconsin	Ozaukee	Bead
23.21.50A	Geological	Cap d'Or	N/A	N/A	Nova Scotia		Geological Sample
23.21.50Ab	Geological	Cap d'Or	N/A	N/A	Nova Scotia		Geological Sample
23.21.51A	Geological	Cap d'Or	N/A	N/A	Nova Scotia		Geological Sample
34.21.37E	Geological	Centennial Mine	N/A	N/A	Michigan	Houghton	Geological Sample

Copper Trace Element Data: Sample Descriptions

Sample No.	samp_type	Site/Source	Age	Association	State/Province	County	Description
34.21.37J	Geological	Centennial Mine	N/A	N/A	Michigan	Houghton	Geological Sample
34.21.37NA	Geological	Centennial Mine	N/A	N/A	Michigan	Houghton	Geological Sample
34.21.37NB	Geological	Centennial Mine	N/A	N/A	Michigan	Houghton	Geological Sample
34.21.37NC	Geological	Centennial Mine	N/A	N/A	Michigan	Houghton	Geological Sample
34.21.37P	Geological	Centennial Mine	N/A	N/A	Michigan	Houghton	Geological Sample
34.21.45B	Geological	Champion Mine	N/A	N/A	Michigan	Houghton	Geological Sample
34.21.45C	Geological	Champion Mine	N/A	N/A	Michigan	Houghton	Geological Sample
34.21.45D	Geological	Champion Mine	N/A	N/A	Michigan	Houghton	Geological Sample
34.21.45E	Geological	Champion Mine	N/A	N/A	Michigan	Houghton	Geological Sample
34.21.45G	Geological	Champion Mine	N/A	N/A	Michigan	Houghton	Geological Sample
34.21.45H	Geological	Champion Mine	N/A	N/A	Michigan	Houghton	Geological Sample
34.21.45I	Geological	Champion Mine	N/A	N/A	Michigan	Houghton	Geological Sample
34.21.45J	Geological	Champion Mine	N/A	N/A	Michigan	Houghton	Geological Sample
34.21.45K	Geological	Champion Mine	N/A	N/A	Michigan	Houghton	Geological Sample
34.21.45L	Geological	Champion Mine	N/A	N/A	Michigan	Houghton	Geological Sample
37.21.61A	Geological	Cornwall	N/A	N/A	Pennsylvania	Lebanon	Geological Sample
36.21.60A	Geological	Gold Hill	N/A	N/A	North Carolina	Rowan	Geological Sample
37.21.62	Geological	Greenstone	N/A	N/A	Pennsylvania	Adams	Geological Sample
37.21.62	Geological	Greenstone	N/A	N/A	Pennsylvania	Adams	Geological Sample
26.21.04C1.11	Geological	Michipicoten Island	N/A	N/A	Ontario		Geological Sample
26.21.04C1.20	Geological	Michipicoten Island	N/A	N/A	Ontario		Geological Sample
26.21.04C1.24	Geological	Michipicoten Island	N/A	N/A	Ontario		Geological Sample
26.21.04C1.27	Geological	Michipicoten Island	N/A	N/A	Ontario		Geological Sample
26.21.04C1.30	Geological	Michipicoten Island	N/A	N/A	Ontario		Geological Sample
26.21.04C1.8	Geological	Michipicoten Island	N/A	N/A	Ontario		Geological Sample
34.21.34BA	Geological	Minesota Mine	N/A	N/A	Michigan	Ontonagon	Geological Sample
34.21.34BAa	Geological	Minesota Mine	N/A	N/A	Michigan	Ontonagon	Geological Sample
34.21.34BAb	Geological	Minesota Mine	N/A	N/A	Michigan	Ontonagon	Geological Sample
34.21.34BAc	Geological	Minesota Mine	N/A	N/A	Michigan	Ontonagon	Geological Sample
34.21.34CA	Geological	Minesota Mine	N/A	N/A	Michigan	Ontonagon	Geological Sample
34.21.66A	Geological	Minong Mine	N/A	N/A	Michigan	Isle Royale/Keweenaw	Geological Sample
34.21.66B	Geological	Minong Mine	N/A	N/A	Michigan	Isle Royale/Keweenaw	Geological Sample
34.21.66C	Geological	Minong Mine	N/A	N/A	Michigan	Isle Royale/Keweenaw	Geological Sample

Copper Trace Element Data: Sample Descriptions

Sample No.	samp_type	Site/Source	Age	Association	State/Province	County	Description
34.21.66D	Geological	Minong Mine	N/A	N/A	Michigan	Isle Royale/Keweenaw	Geological Sample
34.21.66E	Geological	Minong Mine	N/A	N/A	Michigan	Isle Royale/Keweenaw	Geological Sample
34.21.66F	Geological	Minong Mine	N/A	N/A	Michigan	Isle Royale/Keweenaw	Geological Sample
34.21.66G	Geological	Minong Mine	N/A	N/A	Michigan	Isle Royale/Keweenaw	Geological Sample
34.21.66H	Geological	Minong Mine	N/A	N/A	Michigan	Isle Royale/Keweenaw	Geological Sample
34.21.34AA	Geological	Quincy Mine	N/A	N/A	Michigan	Houghton	Geological Sample
34.21.80C	Geological	Snake River	N/A	N/A	Minnesota	Pine	Geological Sample
34.21.80D	Geological	Snake River	N/A	N/A	Minnesota	Pine	Geological Sample
34.21.80G	Geological	Snake River	N/A	N/A	Minnesota	Pine	Geological Sample
34.21.80I	Geological	Snake River	N/A	N/A	Minnesota	Pine	Geological Sample
34.21.80J	Geological	Snake River	N/A	N/A	Minnesota	Pine	Geological Sample
34.21.80K	Geological	Snake River	N/A	N/A	Minnesota	Pine	Geological Sample
34.21.80O	Geological	Snake River	N/A	N/A	Minnesota	Pine	Geological Sample
34.21.80R	Geological	Snake River	N/A	N/A	Minnesota	Pine	Geological Sample
34.21.80S	Geological	Snake River	N/A	N/A	Minnesota	Pine	Geological Sample
34.21.80T	Geological	Snake River	N/A	N/A	Minnesota	Pine	Geological Sample
28.21.02	Geological	Trout River	N/A	N/A	Newfoundland		Geological Sample
28.21.02A	Geological	Trout River	N/A	N/A	Newfoundland		Geological Sample
28.21.02B	Geological	Trout River	N/A	N/A	Newfoundland		Geological Sample
28.21.02C	Geological	Trout River	N/A	N/A	Newfoundland		Geological Sample
37.21.69B	Geological		N/A	N/A	Pennsylvania	Adams	Geological Sample
37.21.69C	Geological		N/A	N/A	Pennsylvania	Adams	Geological Sample
37.21.69D	Geological		N/A	N/A	Pennsylvania	Adams	Geological Sample
37.21.69F	Geological		N/A	N/A	Pennsylvania	Adams	Geological Sample
37.21.69G	Geological		N/A	N/A	Pennsylvania	Adams	Geological Sample

Copper Trace Element Data: Sodium through Manganese

Sample No.	Na	Mg	Al	Si	P	S	Sc	Ti	V	Cr	Mn
51.6B1	1.59	0.83	26.62	1.76	4.67	0.05	0.04	0.05	30.88	0.12	0.29
51.6B1	0.00	0.27	24.73	2.61	4.64	0.33	0.00	0.03	38.72	0.00	0.23
56.7B1	9.21	2.90	141.87	289.91	37.40	0.00	1.76	0.12	155.76	0.81	0.29
56.7B1	52.63	4.11	572.41	608.37	65.04	1.47	1.90	0.47	188.02	0.01	1.14
59.07B4	0.94	0.00	16.49	0.65	5.78	0.27	0.00	0.01	70.51	0.00	0.00
59.07B4	0.00	1.01	42.49	2.73	5.87	0.23	0.00	0.08	66.34	0.19	0.32
62.25B5	4.80	1.55	55.21	1.29	4.59	0.39	0.14	0.05	37.01	0.21	0.25
62.25B5	0.76	0.00	42.13	0.96	5.58	0.43	0.00	0.04	24.41	0.00	0.12
63.6B4	3.09	0.11	10.29	1.20	6.17	0.00	0.00	0.06	9.85	0.17	0.28
63.6B4	10.51	0.73	37.38	1.74	8.44	0.00	0.00	0.07	52.54	0.26	0.16
63.6B4	0.83	0.37	35.88	1.35	3.63	0.29	0.12	0.03	31.52	0.06	0.25
65.26B4	1.08	0.41	24.32	0.27	17.37	0.00	0.19	0.09	15.21	0.22	0.20
66.29B2	0.29	0.00	40.30	1.77	5.32	0.58	0.00	0.03	92.65	0.00	0.02
66.29B2	0.00	0.12	51.62	1.71	5.75	0.36	0.07	0.03	70.54	0.18	0.04
TP10B1	10.10	1.72	103.91	1.90	13.82	0.00	0.16	0.05	179.92	0.60	0.22
TP10B1	0.00	0.11	38.23	0.54	8.21	0.60	0.08	0.04	58.78	0.13	0.04
96E1.254	11.31	239.68	609.92	300.31	1.04	0.00	1.99	1.56	527.33	0.02	46.44
96E1.254	1.97	0.71	76.53	12.06	0.49	0.68	0.04	0.04	29.71	0.07	2.10
96E1.255	6.83	0.16	10.21	5.42	0.00	0.00	0.19	0.02	16.61	0.00	0.00
96E1.265	10.21	5.26	488.85	158.53	4.98	0.00	0.61	0.45	199.25	0.37	0.78
96E1.265	2.60	0.17	6.23	11.85	0.06	0.18	0.00	0.05	9.98	0.00	0.10
96E1.271	0.19	0.74	28.62	7.09	0.00	0.76	0.23	0.02	12.03	0.17	0.10
96E1.271	0.37	0.87	5.86	3.80	0.09	0.55	0.02	0.01	3.41	0.40	0.08
96E1.278	5.39	1.24	22.96	14.95	0.41	0.00	0.00	0.07	18.93	0.24	0.45
96E1.286	5.10	0.61	457.29	153.11	0.48	0.00	0.94	0.04	102.37	0.00	0.49
96E1.286	0.28	0.00	9.84	70.69	0.06	0.37	0.06	0.01	10.29	0.00	0.07
96E1.290	7.55	2.75	35.33	8.31	0.35	0.00	0.00	0.51	121.96	0.45	4.00
96E1.294	1.36	0.00	25.95	7.71	0.18	0.55	0.00	0.01	8.85	0.00	0.75
96E1.294	0.00	0.22	11.18	12.24	0.06	0.49	0.05	0.01	10.70	0.34	0.10
96E1.305	8.41	0.00	1.17	4.07	0.00	0.00	0.00	0.01	4.42	0.00	0.00
96E1.305	0.00	0.00	2.32	4.89	0.01	0.21	0.00	0.00	3.39	0.00	0.06
96E1.309	2.91	0.61	17.92	23.12	0.09	0.00	0.00	0.06	24.19	0.12	0.18

Copper Trace Element Data: Sodium through Manganese

Sample No.	Na	Mg	Al	Si	P	S	Sc	Ti	V	Cr	Mn
96E1.316	18.14	19.58	72.21	15.24	4.05	1.03	0.00	0.09	55.96	0.00	54.02
96E1.316	0.00	34.10	88.52	8.28	4.29	0.11	0.17	0.13	49.48	0.61	67.86
96E1.318	4.30	1.08	27.74	11.32	0.00	0.00	0.00	0.05	8.52	0.37	1.26
96E1.513	17.03	159.79	3149.53	557.28	23.85	0.00	7.54	12.68	13821.64	3.64	121.94
96E1.523	10.69	0.99	15.36	10.45	0.09	0.00	0.19	0.02	14.38	0.34	0.12
96E1.523	0.00	0.42	50.99	16.01	1.09	1.13	0.02	0.06	39.51	0.00	0.45
96E1.60	0.00	0.08	14.94	4.21	0.19	0.18	0.00	0.01	5.64	0.04	0.12
96E1.618	34.22	13.10	161.38	700.18	1.16	0.00	5.33	0.20	49.00	1.07	18.74
96E1.653	15.53	3.43	14.98	7.74	0.00	0.00	1.19	0.03	9.56	1.41	0.29
96E1.653	0.00	0.18	7.78	11.11	0.04	0.47	0.04	0.02	8.75	0.05	0.37
96E1.695	5.52	3.41	40.15	51.96	0.33	0.00	0.46	0.03	36.54	0.18	1.51
96E1.695	4.98	1.53	8.31	68.07	0.44	0.46	0.14	0.02	11.42	0.47	3.31
96E1.702	8.45	1.68	12.32	77.55	0.00	0.00	0.77	0.02	39.70	0.42	0.26
Unit B	2.22	0.25	5.24	0.00	1.87	0.00	0.07	0.03	2.51	0.08	0.00
Unit B	2.23	0.84	9.25	1.48	4.02	0.00	0.30	0.07	5.55	0.23	0.11
1743.108	0.73	0.12	12.52	0.51	13.72	0.00	0.00	0.12	8.57	0.00	0.04
1743.108	0.76	0.09	7.98	0.18	12.60	0.00	0.04	0.08	10.66	0.00	0.00
1748.18	3.39	0.16	6.39	0.00	4.64	0.00	0.12	0.03	2.60	0.08	0.00
1748.18	2.96	1.43	12.49	0.00	9.00	0.00	0.77	0.12	4.03	0.58	0.17
1749.55	1.06	0.22	5.83	0.00	6.56	0.00	0.05	0.08	10.62	0.05	0.03
1749.55	0.82	1.19	24.94	4.81	26.69	0.00	0.22	0.36	22.26	0.17	0.50
1749.56	0.96	0.35	25.69	2.18	26.69	1.73	0.00	0.27	15.16	0.00	0.12
1749.56	0.73	0.14	13.56	0.55	20.44	0.06	0.01	0.22	6.69	0.00	0.04
1751.42	0.94	0.00	4.75	3.59	4.96	0.00	0.00	0.06	8.51	0.00	0.00
1751.42	0.43	0.26	9.14	0.68	15.36	0.00	0.11	0.11	12.85	0.10	0.02
1744.147A	3.41	0.38	14.48	0.00	19.64	0.00	0.20	0.17	7.04	0.15	0.01
1744.147A	1.13	1.08	40.23	0.53	40.87	0.00	0.56	0.29	15.62	0.57	0.23
1744.147B	3.68	1.58	34.30	4.89	23.34	0.00	0.27	0.49	18.91	0.21	0.29
1744.147B	0.22	1.38	22.79	1.20	17.29	0.00	0.52	0.25	17.66	0.56	0.24
1744.147C	1.45	0.37	21.57	1.33	25.67	0.00	0.13	0.22	10.00	0.11	0.08
1744.147C	2.53	2.74	26.74	0.00	14.06	0.00	1.41	0.17	9.69	1.45	0.43
1744.147D	1.31	0.29	55.24	1.99	27.85	0.00	0.02	0.33	24.93	0.02	0.09
1744.147D	1.48	0.48	46.20	1.32	36.40	0.00	0.12	0.25	21.49	0.12	0.08

Copper Trace Element Data: Sodium through Manganese

Sample No.	Na	Mg	Al	Si	P	S	Sc	Ti	V	Cr	Mn
1744.147E	1.93	0.24	17.49	1.65	11.00	0.00	0.02	0.10	9.54	0.05	0.05
1744.147E	1.99	0.57	12.67	0.17	9.30	0.00	0.22	0.11	8.61	0.21	0.09
RghB13A	2.53	6.53	14.70	10.60	3.67	0.00	0.17	0.35	5.35	0.24	2.91
RghB13A	0.43	2.46	2.03	0.00	2.53	0.00	0.27	0.03	4.93	0.24	0.36
RghB13A	0.00	2.26	6.45	0.00	0.00	0.00	0.99	0.07	1.46	1.00	0.26
RghB13B	0.14	0.64	1.80	0.00	0.00	0.00	0.25	0.02	2.15	0.25	0.08
RghB13B	0.00	4.52	4.37	1.13	21.48	0.00	0.52	0.05	28.78	0.54	0.22
RghB13C	0.00	8.43	3.54	0.02	10.94	0.00	0.43	0.06	10.81	0.40	1.88
RghB13C	0.00	2.62	4.49	0.66	3.45	0.00	0.39	0.06	10.95	0.46	0.61
RghB13D	0.72	4.65	1.13	0.06	6.89	0.00	0.11	0.04	9.99	0.15	1.03
RghB13D	0.57	1.31	0.00	2.68	86.33	50.19	0.00	0.00	5.95	0.00	0.19
RghB13E	0.76	0.41	0.77	0.00	1.38	0.00	0.10	0.01	0.42	0.13	0.04
RghB13E	2.74	0.00	0.00	0.00	33.62	0.00	0.00	0.00	0.41	0.00	0.00
RghB13F	1.03	0.00	0.00	0.00	30.22	3.89	0.00	0.00	1.81	0.00	0.00
RghB13F	1.00	3.46	4.24	0.48	416.59	0.00	0.49	0.03	15.36	0.54	0.28
RghB13G	2.10	0.29	0.64	0.83	173.02	0.00	0.00	0.00	6.88	0.00	0.04
RghB13G	0.00	3.24	7.88	6.44	428.16	0.00	0.57	0.09	16.07	0.66	0.38
RghB13H	0.48	2.53	0.79	5.64	1026.76	300.83	0.02	0.01	38.03	0.00	0.16
RghB13H	0.00	7.50	9.74	7.03	1409.73	1733.40	0.20	0.08	111.79	0.27	2.23
RghB13I	0.00	0.30	0.83	0.13	28.60	0.00	0.07	0.00	4.21	0.00	0.02
RghB13I	0.00	1.25	3.52	0.00	4.19	0.00	0.46	0.03	1.56	0.77	0.12
RghB13J	0.05	1.75	2.01	0.00	572.33	1.46	0.12	0.01	15.68	0.05	0.16
RghB13J	0.00	3.75	7.61	0.84	287.04	0.00	0.96	0.06	10.10	1.55	0.36
RghB13K	0.00	3.78	9.97	5.20	987.73	518.47	0.01	0.01	32.50	0.03	0.12
RghB13K	0.00	1.17	2.78	0.52	56.73	0.00	0.36	0.02	9.66	0.62	0.10
RghB13L	0.36	3.53	11.44	9.36	61.58	0.00	0.05	0.11	3.15	0.01	1.05
RghB13L	0.00	2.02	6.31	0.00	38.79	0.00	0.66	0.07	5.59	1.09	0.22
RghB13L	0.00	4.23	7.60	2.39	904.48	0.00	0.13	0.03	41.62	0.20	0.15
RghB18	1.07	1.04	5.01	7.50	110.94	33.03	0.08	0.02	18.42	0.02	0.11
RghB18	0.04	1.40	3.70	2.81	69.73	0.00	0.45	0.01	14.29	0.28	0.13
RghB23	5.73	4.33	3.63	4.41	249.50	0.00	0.15	0.10	6.86	0.00	0.19
RghB23	1.09	2.72	2.42	0.45	103.28	68.06	0.30	0.06	1.39	0.16	0.53
RvF13A	0.34	15.33	68.55	47.36	206.78	17.51	0.00	0.09	52.48	0.00	6.06

Copper Trace Element Data: Sodium through Manganese

Sample No.	Na	Mg	Al	Si	P	S	Sc	Ti	V	Cr	Mn
RvF13A	1.45	0.29	18.34	0.31	88.20	0.00	0.00	0.01	13.99	0.00	0.77
RvF13B	0.20	0.00	0.59	0.00	43.39	1.26	0.00	0.00	10.14	0.00	0.09
RvF13B	2.84	53.10	130.69	34.16	521.82	7.78	0.04	0.13	51.36	0.00	7.89
RvF13C	2.97	14.92	64.92	144.21	197.06	4.54	0.31	0.20	56.81	0.00	8.94
RvF13C	0.43	9.54	67.96	9.91	429.19	6.00	0.00	0.06	44.64	0.00	2.64
RvF13D	0.16	15.43	23.90	8.92	166.92	6.23	0.30	0.03	31.13	0.00	1.82
RvF13D	0.11	8.49	17.60	7.56	28.00	0.00	0.55	0.03	7.66	0.00	0.69
RvF13E	15.22	48.46	211.79	0.00	107.70	0.00	19.32	0.19	43.33	0.00	5.49
RvF13E	2.86	25.24	205.79	27.74	293.88	0.00	6.63	0.24	101.72	0.00	5.96
RvF13F	1.94	52.37	270.13	104.12	290.99	2.09	6.59	0.25	116.29	0.47	8.85
RvF13F	0.14	5.01	14.38	0.68	41.96	1.68	1.09	0.02	14.20	0.16	0.79
RvF13H	0.00	20.29	46.20	3.91	72.65	0.00	5.67	0.04	27.56	2.01	1.53
RvF13H	0.00	30.05	62.99	4.30	24.68	0.00	8.35	0.05	17.76	3.54	1.82
RvF13I	0.00	10.72	71.29	2.85	412.49	10.05	0.92	0.04	63.00	0.59	4.70
RvF13I	0.00	23.69	52.75	0.00	19.36	0.00	8.19	0.05	13.45	4.41	1.55
RvF13J	0.00	23.96	54.76	4.45	425.44	27.02	7.50	0.06	99.93	5.06	1.72
RvF13J	0.00	142.10	280.90	25.62	34.80	0.00	44.70	0.25	43.43	27.24	8.78
RvF13K	0.00	29.90	81.14	44.93	19.26	0.00	8.75	0.05	14.37	5.54	1.95
RvF13K	0.00	85.53	240.37	110.59	115.67	0.00	24.31	0.17	93.07	16.59	6.44
RvF17A	226.76	28.39	117.19	38.75	39.02	0.00	5.58	6.10	90.43	0.00	1.60
RvF17A	0.00	1.57	11.44	4.18	45.05	18.34	0.35	0.02	17.61	0.30	0.36
RvF17B	0.72	0.62	3.26	5.30	40.82	38.11	0.10	0.01	10.52	0.00	0.55
RvF17B	0.00	0.97	4.71	0.38	25.77	229.19	0.39	0.01	2.22	0.36	0.19
RvF17C	4.45	3.72	30.22	3.30	226.20	16.94	1.43	0.05	77.46	0.24	0.52
RvF17C	0.00	2.12	18.88	1.69	9.32	1.79	1.22	0.02	9.45	0.77	0.51
RvF17D	0.00	0.60	3.40	1.45	11.09	145.86	0.17	0.01	2.27	0.05	0.18
RvF17D	0.12	2.90	242.09	1.49	771.94	77.48	0.84	0.05	4.39	0.81	0.54
RvF17E	0.70	19.50	23.96	2.87	53.62	50.91	1.48	4.36	14.37	0.74	0.81
RvF17E	0.00	2728.90	8464.82	0.00	0.00	0.00	1425.78	19.35	1223.50	1208.12	217.57
RvF17F	0.31	0.92	13.84	1.40	70.35	14.41	0.28	0.02	12.23	0.14	0.27
RvF17F	0.00	1.80	7.44	0.58	16.32	2.80	0.67	0.02	7.77	0.63	0.34
RvF17G	0.00	0.61	3.09	1.83	14.82	73.98	0.24	0.01	4.13	0.16	0.13
RvF17G	0.00	0.85	6.32	1.05	11.17	61.67	0.27	0.01	5.45	0.25	0.11

Copper Trace Element Data: Sodium through Manganese

Sample No.	Na	Mg	Al	Si	P	S	Sc	Ti	V	Cr	Mn
RvF1G	0.00	19.47	56.02	7.22	59.19	0.00	7.14	0.07	29.17	1.60	1.67
RvF1G	0.38	19.51	52.58	7.38	162.01	0.00	5.50	0.06	48.11	1.69	1.71
RvF27	4.30	0.78	4.81	0.00	63.26	0.00	0.28	0.01	4.37	0.00	0.17
RvF27	0.45	1.17	6.22	0.00	72.13	0.00	0.44	0.01	6.75	0.06	0.17
RvF29A	3.80	0.00	0.00	0.32	0.00	0.00	0.00	0.01	1.17	0.00	0.05
RvF29A	1.72	0.90	4.02	2.95	0.00	0.00	0.36	0.01	0.89	0.00	0.20
RvF29B	12.49	1.10	1.04	0.00	0.00	0.00	0.02	0.05	4.33	0.00	0.19
RvF29B	0.00	1.28	0.95	0.07	4.46	0.00	0.09	0.00	2.23	0.00	0.25
RvF37A	7.36	0.97	2.88	6.31	10.72	0.00	0.00	0.10	4.94	0.00	0.49
RvF37A	0.00	2623.89	7103.85	1920.33	0.00	0.00	1070.50	11.72	1267.44	1517.76	207.60
RvF37A	2.75	0.30	0.38	0.84	316.63	10.05	0.07	0.02	1.51	0.00	0.17
RvF37B	12.72	6.04	12.39	11.80	112.58	0.00	0.63	0.03	13.27	0.26	2.72
RvF37B	3.43	0.00	0.31	1.97	227.52	302.37	0.10	0.01	0.90	0.00	0.11
RvF37C	1.20	3.17	8.86	6.20	11.03	0.00	1.17	0.02	3.99	0.63	0.42
RvF37C	1.22	0.35	0.00	0.00	497.88	1.60	0.04	0.01	2.33	0.00	0.30
RvF37D	110.17	2438.98	6810.16	3314.61	0.00	0.00	907.92	12.29	1403.16	687.51	256.52
RvF37D	4.17	0.38	3.09	0.22	111.77	184.83	0.33	0.02	0.50	0.00	0.18
RvF37D	0.84	0.34	1.09	0.11	316.34	472.98	0.14	0.03	0.66	0.00	0.18
RvF37E	0.00	0.71	2.43	1.46	16.06	0.00	0.27	0.01	2.37	0.21	0.13
RvF37E	2.75	0.19	0.78	0.35	558.06	0.00	0.17	0.02	3.29	0.00	0.07
RvF37F	0.00	1.17	5.26	1.91	15.35	56.71	0.32	0.01	5.48	0.29	0.32
RvF37F	23.95	6.06	25.24	11.03	2221.65	0.00	3.62	0.26	29.98	1.10	1.51
RvF37G	0.00	3.34	8.65	2.68	27.08	3.63	0.62	0.01	6.78	0.74	0.76
RvF37G	3.85	1.57	4.15	2.10	362.69	0.00	1.19	0.08	1.39	0.38	0.32
RvF37H	0.00	1.35	4.25	1.32	22.89	9.03	0.44	0.01	2.32	0.51	0.39
RvF37H	4.46	3.62	15.35	3.01	1377.66	64.32	2.31	0.14	14.81	0.82	0.53
RvF37I	0.00	1.66	5.99	4.58	17.69	0.07	0.33	0.01	5.25	0.57	0.30
RvF37I	0.16	1.13	5.92	0.05	444.36	3.95	0.45	0.06	3.50	0.17	0.40
RvF37J	0.32	1.48	2.64	0.88	3.61	15.58	0.27	0.01	1.44	0.61	0.38
RvF37J	2.85	5.81	19.36	0.00	227.32	0.00	3.41	0.21	5.51	1.62	2.25
RvF37K	0.00	2.80	11.69	4.20	28.23	8.97	0.29	0.04	6.26	0.58	1.43
RvF37K	1.02	2.34	9.08	0.00	1394.11	0.00	0.95	0.09	5.07	0.52	2.68
RvF37L	0.00	2.17	5.41	2.32	19.62	0.00	0.65	0.01	3.36	1.33	0.52

Copper Trace Element Data: Sodium through Manganese

Sample No.	Na	Mg	Al	Si	P	S	Sc	Ti	V	Cr	Mn
RvF37L	2.32	1.97	5.40	0.00	1231.13	0.00	0.78	0.07	2.34	0.48	0.71
RvF37L	0.00	1.98	7.58	0.00	519.85	0.00	0.79	0.10	3.94	0.52	0.36
RvF37M	0.00	4.61	12.40	0.66	9.75	0.00	1.75	0.03	3.15	3.46	0.70
RvF37M	0.00	1.84	5.90	0.00	637.06	0.00	0.72	0.07	2.63	0.46	0.47
RvF37N	0.00	2765.69	6301.17	319.31	0.00	0.00	1045.01	15.18	1021.54	1827.13	221.52
RvF37N	0.00	1.83	7.22	0.00	32.23	111.30	0.86	0.08	1.35	0.76	0.24
RvF37N	0.00	2.35	7.68	0.00	504.98	0.00	1.03	0.07	2.06	0.95	0.41
RvF43	0.00	2.40	18.70	0.78	88.73	0.00	0.71	0.03	7.41	0.53	0.75
RvF43	0.00	7.12	71.15	19.61	137.23	0.77	0.74	0.12	16.85	0.66	1.70
Th50787	4.78	3.57	7.89	7.43	41.75	0.00	0.51	0.06	1.78	0.24	0.85
Th50787	0.00	3.86	9.28	2.63	52.87	0.00	1.25	0.07	2.38	1.17	0.34
Th50790A	0.21	0.41	1.18	0.12	0.52	148.28	0.14	0.01	0.43	0.08	0.06
Th50790A	0.00	1.79	4.90	0.44	0.39	0.00	0.60	0.03	0.99	0.77	0.19
Th50790B	6.59	6.63	24.41	13.67	5.36	0.00	1.83	0.35	7.27	1.64	0.67
Th50790B	0.00	4.71	13.72	6.07	19.87	0.00	1.50	0.09	3.68	2.00	0.65
23.21.50A	2.50	0.00	52.95	46.59	0.26	52.24	0.00	0.01	2.13	0.00	0.00
23.21.50Ab	0.85	1.54	21.70	11.03	0.00	0.00	0.27	0.14	11.27	0.28	0.28
23.21.51A	1.20	6.28	41.39	1.46	0.12	4.93	1.89	0.00	6.51	7.77	1.08
34.21.37E	54.18	2961.31	20657.08	6796.86	156.03	130.43	26.77	4.98	316.25	0.00	66.93
34.21.37J	0.41	41.50	87.16	26.76	0.15	3.97	5.50	0.93	40.83	0.00	1.36
34.21.37NA	0.00	0.00	34.19	19.87	0.01	2.54	0.00	0.02	10.02	0.00	5.56
34.21.37NB	0.07	0.17	24.48	12.92	0.00	11.61	0.00	0.00	10.76	0.00	2.35
34.21.37NC	0.00	47.09	182.27	75.32	0.45	9.49	1.72	0.22	63.02	0.00	8.69
34.21.37P	0.18	14.59	10.25	37.79	0.90	7.59	0.00	0.09	1.71	0.00	1.18
34.21.45B	0.00	13.43	53.92	0.00	0.00	13.17	8.30	0.05	0.75	1.50	1.67
34.21.45C	0.00	226.06	372.53	90.94	0.34	28.46	5.34	0.94	73.94	1.47	4.33
34.21.45D	0.00	40.56	33.67	9.35	0.19	10.74	1.01	0.03	13.06	0.00	10.72
34.21.45E	0.00	34.80	103.60	20.62	0.00	43.34	18.65	0.10	0.32	2.76	4.72
34.21.45G	0.00	76.69	488.32	174.32	0.79	11.82	3.72	0.15	167.55	0.15	11.52
34.21.45H	1.59	21.01	50.55	4.32	0.00	7.44	5.07	0.16	5.67	0.04	3.01
34.21.45I	0.00	18.59	27.65	0.00	0.00	0.00	3.91	0.00	0.96	1.28	1.00
34.21.45J	0.00	20.72	41.46	0.00	0.00	0.00	5.51	0.07	0.56	0.72	1.24
34.21.45K	0.00	42.81	21.40	10.35	0.00	0.94	2.58	0.06	3.86	0.90	0.79

Copper Trace Element Data: Sodium through Manganese

Sample No.	Na	Mg	Al	Si	P	S	Sc	Ti	V	Cr	Mn
34.21.45L	0.00	1229.53	351.96	92.33	1.92	26.87	6.02	0.24	224.16	0.00	347.68
37.21.61A	0.00	0.28	10.43	0.34	0.24	4.44	0.00	0.00	0.77	2.68	0.19
36.21.60A	1.45	255.19	2975.46	280.13	902.84	894.07	7.76	1.05	96.76	3.58	27.78
37.21.62	1.70	26.43	112.33	17.52	1.05	8.98	1.47	0.02	30.19	1.14	2.11
37.21.62	0.22	120.00	14.41	42.25	0.65	1.97	0.59	0.00	18.92	0.00	5.29
26.21.04C1.11	4.58	11.54	0.00	1.87	0.03	0.00	0.00	0.04	0.00	0.00	0.04
26.21.04C1.20	0.12	7.78	15.06	5.43	0.07	3.39	3.15	0.00	6.08	2.41	0.20
26.21.04C1.24	0.43	0.95	1.98	1.63	0.05	1.95	0.00	0.00	3.02	0.16	0.27
26.21.04C1.27	0.72	0.00	1.48	1.29	0.07	1.48	0.00	0.00	0.85	0.14	0.12
26.21.04C1.30	0.00	0.00	2.36	0.37	0.13	2.68	0.00	0.02	0.00	0.00	0.00
26.21.04C1.8	0.00	6.04	0.86	1.33	0.07	4.99	0.00	0.00	2.26	0.00	18.41
34.21.34BA	0.00	4.68	19.85	35.74	0.80	93.78	0.00	0.00	0.00	4.73	0.12
34.21.34BAa	0.78	0.68	2.46	1.04	0.00	0.00	0.28	0.03	0.56	0.30	0.00
34.21.34BAb	1.71	3.90	11.98	0.00	0.00	0.00	1.68	0.15	2.44	1.45	0.04
34.21.34BAc	0.88	1.68	5.28	0.00	0.00	0.00	0.67	0.06	0.58	0.63	0.03
34.21.34CA	0.00	3.07	9.59	17.38	0.19	6.70	0.00	0.00	3.08	1.04	0.43
34.21.66A	0.00	0.00	1.90	0.51	0.19	7.14	0.00	0.01	0.00	0.00	0.01
34.21.66B	0.22	61.71	36.29	232.19	3.31	2.54	3.51	0.19	61.45	0.53	2.56
34.21.66C	0.00	141.69	234.65	108.25	2.97	11.79	1.30	0.39	162.65	0.47	3.34
34.21.66D	0.00	100.62	82.37	35.59	0.13	2.40	0.00	0.00	90.13	0.45	3.38
34.21.66E	0.00	11.41	4.57	7.47	0.72	3.24	0.00	0.00	2.73	0.07	0.09
34.21.66F	0.00	30.84	75.97	35.48	6.04	16.67	0.00	0.08	102.62	0.35	1.10
34.21.66G	0.00	152.25	31.22	25.37	0.68	2.15	0.00	0.00	13.48	0.25	1.44
34.21.66H	0.00	29.96	30.16	109.58	0.21	29.59	0.00	0.00	16.71	0.81	2.26
34.21.34AA	0.05	3.76	5.46	2.05	0.09	7.40	0.00	0.01	0.94	0.24	0.42
34.21.80C	52.68	0.00	0.00	33.06	1.20	81.28	0.00	0.06	93.11	0.00	0.00
34.21.80D	12.09	0.00	0.00	16.23	0.55	10.50	0.00	0.14	131.06	0.00	0.00
34.21.80G	0.00	5.93	0.00	3.69	0.83	7.53	0.00	0.03	20.64	0.00	10.03
34.21.80I	2.78	84.73	54.51	31.99	1.03	40.48	0.00	0.66	60.60	0.00	6.21
34.21.80J	5.87	14.18	3.63	3.16	0.11	3.88	0.00	0.06	4.91	0.00	0.88
34.21.80K	4.13	103.95	283.64	87.11	1.66	37.62	0.00	0.23	508.99	0.00	6.41
34.21.80O	8.43	38.57	170.84	94.72	6.15	10.80	0.00	1.68	115.34	0.00	11.98
34.21.80R	3.64	19.09	16.64	22.33	0.67	6.35	0.00	0.09	85.80	0.00	9.95

Copper Trace Element Data: Sodium through Manganese

Sample No.	Na	Mg	Al	Si	P	S	Sc	Ti	V	Cr	Mn
34.21.80S	1.89	269.18	750.17	277.62	5.55	14.91	0.00	3.89	500.25	0.00	22.11
34.21.80T	6.89	0.00	19.44	32.92	0.43	9.02	0.00	0.08	13.93	0.00	2.47
28.21.02	0.00	0.00	3.99	1.28	0.07	164.63	0.00	0.00	1.53	0.58	0.17
28.21.02A	0.60	0.20	0.45	0.00	0.00	0.00	0.07	0.02	0.65	0.11	0.00
28.21.02B	1.01	0.41	0.94	0.00	0.00	0.00	0.09	0.01	0.30	0.23	0.00
28.21.02C	4.89	2.83	9.21	0.00	0.00	0.00	0.96	0.14	1.58	1.73	0.00
37.21.69B	3.58	25.50	2.52	19.92	0.34	8.46	0.00	0.00	1.10	1.22	7.01
37.21.69C	0.72	9.07	0.00	1698.16	0.31	10.82	9.08	0.06	5.10	1.32	0.10
37.21.69D	0.00	0.00	0.00	2.87	0.45	2.18	0.00	0.00	0.00	0.00	0.00
37.21.69F	32.00	6201.57	2192.41	51277.02	38.19	213.44	391.13	0.13	531.16	80.14	228.08
37.21.69G	1.34	0.34	0.00	29.70	0.04	4.08	1.68	0.00	0.18	0.00	0.28

Copper Trace Element Data: Iron through Indium

Sample No.	Fe	Ni	Co	Cu	Zn	As	Mo	Rh	Ag	Cd	In
51.6B1	152.15	10.58	0.10	816183.46	7.82	182878.11	0.59	76.01	615.94	0.03	0.05
51.6B1	59.61	0.00	0.00	780899.41	4.28	218449.29	0.37	61.39	443.80	0.02	0.03
56.7B1	305.46	50.39	0.30	946240.80	9.82	50645.75	0.74	92.66	1913.25	0.03	0.00
56.7B1	718.88	0.00	0.65	976921.60	19.70	19628.68	2.04	97.48	873.17	0.09	0.00
59.07B4	0.00	0.00	0.00	999032.10	1.65	140.78	0.97	87.63	627.87	0.02	0.00
59.07B4	231.63	0.00	0.01	998382.47	3.75	496.16	0.46	74.92	666.26	0.00	0.01
62.25B5	199.94	17.62	0.16	998803.67	8.15	165.05	0.27	103.01	575.07	0.01	0.00
62.25B5	62.63	0.00	0.04	998655.15	5.18	612.42	0.47	79.74	493.23	0.02	0.00
63.6B4	16.80	0.00	0.00	999558.22	7.78	32.55	0.83	75.99	267.86	0.00	0.00
63.6B4	109.29	11.57	0.03	999177.92	3.93	42.04	0.45	107.07	414.29	0.02	0.00
63.6B4	104.41	0.00	0.02	999487.34	4.41	24.90	0.23	83.04	200.10	0.03	0.01
65.26B4	74.55	35.63	0.12	999354.16	9.12	123.72	0.66	48.38	273.34	0.03	0.00
66.29B2	55.66	0.00	0.00	999144.20	2.11	55.85	0.63	87.11	501.35	0.00	0.00
66.29B2	86.35	0.00	0.00	999065.10	2.82	45.92	0.09	77.74	579.10	0.03	0.01
TP10B1	115.00	17.74	0.11	997803.68	6.63	101.39	0.45	96.37	1459.16	0.03	0.02
TP10B1	45.21	0.00	0.00	998343.46	3.19	48.13	0.10	81.36	1342.32	0.01	0.01
96E1.254	22514.50	21.34	5.26	975137.06	14.65	357.44	2.00	105.10	64.91	0.25	0.00
96E1.254	246.07	0.00	0.08	997774.73	3.44	1179.29	0.61	64.90	593.42	0.08	0.00

Copper Trace Element Data: Iron through Indium

Sample No.	Fe	Ni	Co	Cu	Zn	As	Mo	Rh	Ag	Cd	In
96E1.255	51.02	6.31	0.10	999223.97	4.71	250.78	0.12	92.29	324.97	0.02	0.00
96E1.265	1293.73	0.00	0.08	996680.98	8.64	307.87	1.73	121.44	515.75	0.08	0.00
96E1.265	99.66	0.00	0.03	997916.67	3.45	41.80	0.31	64.78	1833.30	0.00	0.00
96E1.271	220.99	12.82	0.10	983453.73	5.10	14979.83	0.29	79.11	1185.21	0.03	0.01
96E1.271	56.35	10.32	0.00	995397.06	5.58	3583.54	0.36	65.98	862.23	0.02	0.05
96E1.278	293.16	0.00	0.06	997174.66	6.85	627.87	0.51	162.86	1653.43	0.05	0.01
96E1.286	534.00	0.00	0.00	897681.64	6.04	100760.98	0.28	168.50	82.22	0.09	0.03
96E1.286	0.00	0.00	0.00	986673.63	4.18	12865.08	0.03	62.01	298.46	0.00	0.01
96E1.290	185.14	11.11	0.06	797756.44	4.83	200578.97	0.80	103.86	1143.90	0.03	0.07
96E1.294	52.53	0.00	0.00	987637.29	2.13	11584.14	0.17	78.43	592.38	0.01	0.01
96E1.294	47.07	0.00	0.02	987478.70	3.87	11934.41	0.27	61.32	431.64	0.00	0.03
96E1.305	0.00	0.00	0.00	999097.28	3.04	145.17	0.34	204.53	527.44	0.00	0.01
96E1.305	0.00	0.00	0.00	999489.44	3.00	38.01	0.21	64.34	392.10	0.00	0.02
96E1.309	76.67	0.00	0.00	998218.78	3.50	317.92	0.59	225.51	1080.29	0.01	0.00
96E1.316	0.00	0.00	0.00	984832.34	8.85	13618.70	0.00	143.95	1103.48	0.00	0.00
96E1.316	472.63	10.37	0.00	992208.00	25.49	5480.88	0.55	92.87	1408.37	0.04	0.02
96E1.318	157.37	11.50	0.06	920978.30	3.95	77739.45	0.38	101.21	930.36	0.02	0.05
96E1.513	56991.23	107.06	2.65	614418.50	41.61	302741.42	9.36	77.85	3805.22	0.59	0.29
96E1.523	96.30	13.44	0.09	998110.12	4.10	171.53	0.56	136.26	1405.17	0.00	0.01
96E1.523	198.06	0.00	0.69	997737.85	7.71	395.97	0.71	91.29	1420.09	0.04	0.00
96E1.60	29.80	0.00	0.07	999286.66	2.72	181.92	0.33	62.74	405.45	0.00	0.04
96E1.618	769.13	90.40	0.54	905789.46	20.09	91688.03	0.48	98.82	475.63	0.10	0.04
96E1.653	375.07	83.16	0.37	998987.13	12.90	25.55	0.00	121.32	327.63	0.04	0.06
96E1.653	39.08	0.00	0.00	999429.43	3.98	24.47	0.15	83.11	382.53	0.00	0.02
96E1.695	244.64	27.71	0.14	999327.14	4.87	12.71	0.48	80.42	153.92	0.03	0.00
96E1.695	75.19	13.89	0.12	999441.57	14.35	13.06	1.04	68.04	256.96	0.10	0.08
96E1.702	146.60	28.77	0.12	993856.62	6.20	5343.69	0.40	92.07	365.61	0.01	0.03
Unit B	11.76	18.28	0.03	913005.80	3.57	86373.92	0.03	59.12	511.05	0.00	0.00
Unit B	99.86	66.52	0.16	859033.03	11.87	140272.79	0.30	43.54	440.04	0.00	0.00
1743.108	25.60	0.00	0.01	999410.94	3.16	58.82	0.28	75.29	374.26	0.01	0.00
1743.108	24.82	9.38	0.01	999287.95	7.73	71.88	0.31	55.87	499.31	0.02	0.00
1748.18	3.86	0.00	0.00	999108.54	5.75	0.00	0.24	70.34	787.02	0.02	0.00
1748.18	226.33	134.93	0.67	999023.93	23.14	0.00	0.68	55.56	493.24	0.10	0.05

Copper Trace Element Data: Iron through Indium

Sample No.	Fe	Ni	Co	Cu	Zn	As	Mo	Rh	Ag	Cd	In
1749.55	32.25	12.86	0.05	998679.73	14.17	666.33	0.15	60.70	501.24	0.03	0.00
1749.55	260.32	42.20	0.39	987783.06	21.01	2089.91	0.59	45.39	9635.89	0.06	0.00
1749.56	112.01	0.00	0.02	986950.03	6.94	90.89	0.58	96.46	12645.03	0.04	0.00
1749.56	40.56	4.82	0.04	991608.98	6.85	392.24	0.27	60.48	7829.65	0.02	0.00
1751.42	3.98	0.00	0.00	998816.03	4.59	708.79	0.22	92.44	316.61	0.00	0.00
1751.42	43.03	29.35	0.07	997574.27	9.40	1779.28	0.20	47.44	444.01	0.00	0.00
1744.147A	50.91	35.40	0.06	990692.91	6.21	700.95	0.16	59.94	8388.52	0.01	0.00
1744.147A	200.70	107.83	0.59	993235.46	40.05	473.90	0.75	44.26	5743.89	0.16	0.03
1744.147B	361.43	48.75	0.20	998370.29	43.55	77.71	0.74	57.94	909.43	0.07	0.00
1744.147B	258.01	102.81	0.46	998129.78	32.10	161.10	0.67	48.88	1179.58	0.12	0.00
1744.147C	85.24	21.11	0.09	998314.34	9.78	309.92	0.28	56.22	1112.19	0.02	0.00
1744.147C	452.95	262.51	1.10	997010.32	58.49	74.57	0.28	42.61	2013.31	0.10	0.18
1744.147D	129.53	0.00	0.03	998535.69	11.57	376.13	0.32	91.95	704.13	0.00	0.04
1744.147D	127.59	24.27	0.12	998580.01	13.23	533.01	0.49	51.12	524.73	0.04	0.00
1744.147E	44.16	8.06	0.06	985974.57	20.41	11371.25	0.52	62.39	2460.84	0.00	0.00
1744.147E	103.10	48.81	0.17	986286.97	11.42	12790.89	0.22	50.42	660.99	0.05	0.01
RghB13A	234.78	44.21	0.32	996882.65	26.82	843.05	0.28	54.62	112.50	0.13	0.00
RghB13A	108.39	61.66	0.28	986764.99	21.20	12143.65	0.61	44.07	800.74	0.14	0.01
RghB13A	319.05	185.00	0.57	998590.88	24.87	441.33	0.50	38.32	377.83	0.34	0.08
RghB13B	84.89	54.93	0.16	998810.26	10.59	341.42	0.41	40.83	633.48	0.05	0.00
RghB13B	180.68	87.34	0.45	994935.61	67.87	2650.50	2.09	38.13	1922.10	0.31	0.03
RghB13C	168.34	82.87	0.75	962446.91	49.44	36233.61	0.67	45.21	548.90	0.26	0.04
RghB13C	495.18	86.73	1.10	995222.38	41.30	2984.02	1.05	36.35	1079.13	0.12	0.01
RghB13D	42.08	40.74	0.84	998824.54	31.78	667.15	0.36	45.04	234.41	0.18	0.00
RghB13D	0.00	0.00	0.16	999290.33	12.19	121.62	0.14	93.49	331.19	0.07	0.00
RghB13E	34.43	29.40	0.21	300226.73	5.41	698497.40	0.07	13.83	1170.97	0.01	0.05
RghB13E	0.00	0.00	0.00	507741.30	4.40	481975.60	0.00	55.39	10174.27	0.00	0.12
RghB13F	0.00	0.00	0.00	998501.50	3.16	33.10	0.08	86.94	1330.22	0.03	0.00
RghB13F	155.48	115.86	0.47	997361.64	49.20	228.34	0.90	79.14	1380.59	0.29	0.08
RghB13G	36.71	13.21	0.06	998934.27	12.15	144.36	0.19	99.93	563.56	0.13	0.05
RghB13G	223.23	133.87	0.65	997143.08	53.76	565.08	0.59	76.08	1322.25	0.27	0.13
RghB13H	27.59	13.19	0.13	994856.52	46.97	413.61	0.54	81.01	3153.57	0.17	0.00
RghB13H	361.05	47.47	0.46	995219.51	91.79	380.63	1.78	63.80	248.83	0.38	0.06

Copper Trace Element Data: Iron through Indium

Sample No.	Fe	Ni	Co	Cu	Zn	As	Mo	Rh	Ag	Cd	In
RghB13I	58.49	32.50	0.16	984729.42	8.06	14390.89	0.01	95.83	640.74	0.01	0.03
RghB13I	209.35	123.06	0.63	982981.82	24.32	15505.68	0.23	71.57	1068.58	0.10	0.13
RghB13J	103.95	40.32	0.28	994991.54	40.30	384.97	0.04	93.48	3720.26	0.13	0.04
RghB13J	437.74	265.86	1.12	998334.34	60.67	255.32	0.18	95.52	226.16	0.42	0.20
RghB13K	68.93	10.66	0.18	996051.23	50.17	405.07	1.13	73.35	1574.68	0.21	0.03
RghB13K	153.10	106.37	0.38	998608.49	22.62	96.63	0.31	64.91	863.62	0.11	0.05
RghB13L	155.40	17.92	0.33	998646.99	40.43	686.49	0.06	68.26	31.24	0.11	0.00
RghB13L	297.76	152.43	0.76	997203.75	38.89	446.92	0.49	85.72	1710.03	0.14	0.13
RghB13L	308.19	70.62	0.80	996417.84	60.98	428.33	1.06	92.04	1447.06	0.24	0.09
RghB18	55.47	18.03	0.16	999209.42	9.92	7.41	0.11	73.68	443.56	0.02	0.02
RghB18	147.34	113.77	0.41	999178.75	13.96	8.71	0.20	90.68	340.19	0.04	0.12
RghB23	47.42	82.43	0.29	998157.26	46.26	82.63	0.22	108.34	1178.55	0.03	0.02
RghB23	196.04	93.06	0.38	998502.94	161.67	25.48	0.42	78.83	527.56	0.42	0.06
RvF13A	2900.77	0.00	0.14	988234.50	16.45	7946.69	0.48	101.27	332.22	0.05	0.01
RvF13A	153.25	0.00	0.00	996976.47	2.45	2388.87	0.36	75.87	250.62	0.00	0.01
RvF13B	41.58	0.00	0.00	999574.97	3.40	236.95	0.39	55.29	27.97	0.00	0.00
RvF13B	3014.34	50.33	0.73	993846.36	30.51	2080.49	0.88	100.08	40.50	0.05	0.00
RvF13C	2264.88	78.68	0.49	994791.35	15.42	2089.18	0.46	104.80	63.53	0.09	0.06
RvF13C	1314.58	13.18	0.10	988189.08	17.51	9643.25	0.38	66.29	155.32	0.03	0.03
RvF13D	1148.62	40.37	0.21	997644.36	16.33	611.34	0.35	72.72	177.03	0.00	0.05
RvF13D	594.30	58.61	0.17	998736.85	5.38	235.85	0.22	71.88	219.70	0.02	0.05
RvF13E	6761.31	1022.86	3.58	989215.24	79.32	1885.18	1.16	170.14	284.57	0.57	1.00
RvF13E	6362.44	353.53	0.16	989534.87	52.63	2745.56	2.79	109.78	131.23	0.07	0.39
RvF13F	3940.61	253.72	0.95	991153.61	48.99	3561.74	1.17	99.09	52.40	0.10	0.09
RvF13F	628.91	48.91	0.30	998714.14	11.02	322.86	0.28	65.69	109.36	0.00	0.02
RvF13H	1136.86	204.38	0.70	997139.74	27.41	1039.13	0.30	83.31	180.57	0.11	0.08
RvF13H	1602.28	307.71	0.82	997143.64	44.76	380.22	0.36	96.59	259.96	0.04	0.23
RvF13I	962.05	43.00	0.21	995327.48	22.50	2950.69	0.70	62.62	26.97	0.03	0.02
RvF13I	1568.33	335.43	1.01	997320.16	30.64	256.24	0.39	93.84	232.27	0.11	0.18
RvF13J	1333.83	323.13	1.09	982746.31	60.18	14282.42	1.97	92.44	470.73	0.00	0.22
RvF13J	7595.22	1776.11	4.85	879294.10	155.46	110123.54	1.71	149.16	238.63	0.58	0.95
RvF13K	1438.12	342.32	1.01	997320.45	42.64	355.10	0.21	93.00	194.04	0.10	0.23
RvF13K	3850.01	896.12	3.20	992825.89	109.85	1245.72	1.33	88.53	264.58	0.21	0.70

Copper Trace Element Data: Iron through Indium

Sample No.	Fe	Ni	Co	Cu	Zn	As	Mo	Rh	Ag	Cd	In
RvF17A	1453.51	3490.65	0.13	975834.95	719.94	17183.84	5.27	281.76	286.14	3.04	0.00
RvF17A	222.81	75.20	0.06	994539.01	24.43	4721.35	0.76	66.10	234.69	0.10	0.09
RvF17B	180.74	53.41	0.18	974574.36	46.96	24837.03	0.38	66.07	131.42	0.09	0.04
RvF17B	199.38	86.74	0.06	997084.99	30.87	2174.34	0.23	66.01	55.75	0.09	0.08
RvF17C	612.60	330.87	0.07	844862.56	63.69	153229.68	1.70	100.04	390.33	0.26	0.10
RvF17C	414.38	162.01	0.14	983830.25	51.42	15102.66	0.25	84.99	283.48	0.12	0.19
RvF17D	103.37	48.06	0.05	999294.57	18.60	260.00	0.29	61.95	38.97	0.05	0.01
RvF17D	562.86	175.05	0.15	995755.52	167.69	1731.49	0.78	81.63	299.28	0.34	0.12
RvF17E	1139.43	375.01	0.25	995572.78	95.79	2339.37	1.39	109.88	150.91	0.12	0.36
RvF17E	303560.31	270536.37	122.41	334727.84	62138.09	7536.55	133.06	3288.22	311.74	116.34	43.85
RvF17F	232.38	56.48	0.04	990287.27	18.76	9054.71	0.32	66.86	138.99	0.09	0.11
RvF17F	280.46	136.61	0.09	990705.15	34.75	8465.37	0.37	73.39	180.28	0.09	0.13
RvF17G	183.95	53.40	0.03	991438.09	11.98	8078.58	0.17	64.38	63.65	0.05	0.04
RvF17G	142.46	47.62	0.03	993735.02	18.97	5837.04	0.24	56.46	65.05	0.04	0.04
RvF1G	2451.60	265.85	0.84	995932.51	28.87	722.27	0.63	95.33	298.84	0.08	0.25
RvF1G	1274.86	230.20	0.70	996586.59	38.42	1203.04	1.17	94.04	264.00	0.09	0.16
RvF27	86.72	90.62	0.08	998570.82	38.64	674.52	0.10	81.06	331.21	0.16	0.04
RvF27	141.66	113.43	0.10	997653.87	33.25	1562.17	0.14	77.76	274.23	0.08	0.14
RvF29A	5.38	0.00	0.00	999763.38	2.23	7.12	0.05	91.57	115.81	0.01	0.00
RvF29A	128.54	84.81	0.07	999433.28	22.19	18.62	0.49	72.25	207.07	0.08	0.02
RvF29B	189.37	129.20	0.21	999094.70	26.69	63.87	0.10	132.15	259.59	0.00	0.00
RvF29B	47.10	16.84	0.02	999673.29	18.80	25.14	0.06	54.87	128.88	0.05	0.02
RvF37A	105.40	0.00	0.00	999470.37	45.38	16.55	0.02	128.53	167.58	0.03	0.00
RvF37A	267087.03	252890.18	1022.04	329843.83	102917.28	26593.73	36.18	1507.48	792.46	200.91	117.08
RvF37A	36.73	1.91	0.00	999374.47	16.37	18.29	0.08	78.33	105.30	0.02	0.00
RvF37B	348.55	399.03	0.54	997962.46	346.06	64.16	0.91	171.33	71.90	0.57	0.46
RvF37B	31.37	15.03	0.00	997957.62	9.04	16.67	0.05	79.71	1270.62	0.00	0.04
RvF37C	355.07	278.48	0.03	998866.47	128.38	40.35	0.67	93.44	146.62	0.15	0.39
RvF37C	11.55	12.05	0.00	999235.14	31.88	17.51	0.25	62.21	111.43	0.03	0.01
RvF37D	266980.89	250718.89	93.91	325482.50	108628.28	28737.26	0.00	1413.10	535.10	280.05	25.75
RvF37D	73.81	98.02	0.04	999241.71	27.44	15.80	0.00	85.73	137.52	0.05	0.08
RvF37D	85.86	38.25	0.03	998627.61	14.01	11.48	0.02	71.17	313.31	0.04	0.08
RvF37E	80.74	64.57	0.04	999312.76	34.15	20.07	0.13	71.86	366.64	0.05	0.03

Copper Trace Element Data: Iron through Indium

Sample No.	Fe	Ni	Co	Cu	Zn	As	Mo	Rh	Ag	Cd	In
RvF37E	40.13	48.56	0.02	998879.71	11.35	25.30	0.22	70.17	336.42	0.00	0.05
RvF37F	241.22	69.19	0.05	998755.75	52.24	15.59	0.37	74.35	623.89	0.12	0.13
RvF37F	830.93	972.27	0.52	994958.09	330.38	225.24	0.53	110.82	104.47	0.50	0.92
RvF37G	191.63	131.61	0.10	999392.36	97.63	30.61	0.24	81.72	5.79	0.18	0.05
RvF37G	216.13	252.70	0.12	998543.45	64.41	66.73	0.18	72.75	314.18	0.05	0.20
RvF37H	194.00	81.81	0.05	959179.23	51.91	17.55	0.13	70.09	40197.54	0.08	0.14
RvF37H	796.53	449.47	0.34	994179.89	133.88	90.67	0.82	83.09	2219.42	0.16	0.39
RvF37I	129.50	95.70	0.08	998553.52	42.38	12.63	0.15	63.31	1033.82	0.05	0.05
RvF37I	160.32	93.19	0.19	999026.78	42.63	18.07	0.17	57.63	121.55	0.03	0.04
RvF37J	103.77	95.26	0.14	999436.32	47.72	9.48	0.21	68.74	178.00	0.09	0.08
RvF37J	958.83	795.76	2.55	997260.98	189.06	98.88	0.47	101.53	243.36	0.44	0.61
RvF37K	216.71	84.38	0.42	999338.47	55.65	21.22	0.16	65.51	82.74	0.10	0.08
RvF37K	242.72	238.99	0.17	997747.46	72.50	41.55	0.40	62.53	124.89	0.12	0.21
RvF37L	229.86	250.13	0.47	998975.98	75.33	28.99	0.38	68.62	247.60	0.14	0.14
RvF37L	284.94	204.08	0.22	997659.47	71.12	24.31	0.26	62.18	283.63	0.19	0.11
RvF37L	272.04	204.82	0.16	975030.22	61.25	26.93	0.00	64.41	23665.35	0.07	0.12
RvF37M	523.80	671.14	0.78	998274.05	109.58	57.22	0.93	78.41	183.98	0.21	0.19
RvF37M	268.21	151.72	0.19	998488.99	52.48	18.36	0.29	62.38	187.86	0.06	0.15
RvF37N	255301.47	354554.00	306.56	297078.21	55767.67	18244.35	35.25	2598.17	1416.73	149.59	151.43
RvF37N	298.56	207.78	0.25	999083.80	59.32	32.72	0.36	63.82	85.48	0.03	0.20
RvF37N	362.04	276.42	0.22	998338.43	74.04	29.02	0.00	66.27	251.89	0.14	0.32
RvF43	231.15	159.81	0.10	998715.54	44.47	71.32	0.53	86.51	182.77	0.19	0.06
RvF43	473.63	123.51	0.19	998667.76	61.81	32.40	0.75	69.15	78.35	0.25	0.16
Th50787	737.40	200.94	0.40	980115.25	28.89	62.85	2.60	90.01	165.82	0.14	0.02
Th50787	422.59	299.60	1.41	974608.77	42.61	63.19	1.74	75.49	564.22	0.35	0.37
Th50790A	65.82	44.02	0.08	998944.42	5.88	21.53	1.10	63.49	655.74	0.03	0.06
Th50790A	209.94	137.98	0.43	999147.63	21.98	43.37	0.85	61.03	352.17	0.05	0.13
Th50790B	688.20	643.62	1.76	998029.06	88.63	55.83	3.15	103.80	282.99	0.46	0.41
Th50790B	1374.46	340.71	1.42	997491.21	58.65	35.69	12.14	76.43	313.46	0.23	0.29
23.21.50A	0.00	0.00	0.00	999448.53	9.70	3.02	0.00	106.15	4.72	0.00	0.00
23.21.50Ab	146.66	92.47	1.47	998256.62	70.71	80.12	0.42	18.31	5.23	0.44	0.58
23.21.51A	1102.58	0.00	0.00	998459.82	89.55	14.54	0.58	125.97	117.86	0.19	0.20
34.21.37E	12545.70	0.00	11.74	947757.51	289.58	3480.81	1.66	102.18	4394.33	0.00	15.79

Copper Trace Element Data: Iron through Indium

Sample No.	Fe	Ni	Co	Cu	Zn	As	Mo	Rh	Ag	Cd	In
34.21.37J	0.00	0.00	0.03	999320.10	2.38	215.73	0.00	88.32	139.57	0.00	0.01
34.21.37NA	1004.02	0.00	0.00	998114.48	0.35	579.57	0.00	79.95	145.59	0.00	0.00
34.21.37NB	996.06	0.00	0.00	998253.91	9.71	349.92	0.06	76.61	247.18	0.00	0.02
34.21.37NC	4516.21	0.00	0.72	993890.41	13.26	882.73	0.11	86.51	200.85	0.00	0.10
34.21.37P	0.00	0.00	0.66	999375.76	19.11	338.10	0.18	105.16	81.88	0.04	0.10
34.21.45B	343.00	382.98	1.00	998338.10	48.18	576.48	0.54	151.59	39.27	0.00	0.06
34.21.45C	707.86	191.86	1.76	998010.25	23.53	79.88	0.00	106.02	66.68	0.07	0.02
34.21.45D	377.81	56.07	0.17	997929.65	79.43	1236.18	0.10	97.75	85.66	0.08	0.06
34.21.45E	384.90	727.46	0.97	997741.09	28.12	461.30	1.16	187.47	215.08	0.37	0.44
34.21.45G	4979.76	78.00	1.30	992992.35	21.84	503.12	0.35	113.41	353.72	0.07	0.06
34.21.45H	625.55	1657.96	0.65	985418.80	4.49	11594.75	0.77	153.68	405.77	0.43	0.00
34.21.45I	2317.36	202.05	1.47	991794.00	19.77	5142.26	0.03	120.98	344.97	0.21	0.23
34.21.45J	3429.59	117.39	2.42	995678.74	11.47	130.85	0.26	128.57	406.51	0.18	0.00
34.21.45K	1078.89	78.53	0.88	998363.50	16.66	121.77	0.17	89.23	159.98	0.12	0.17
34.21.45L	4542.81	46.67	4.39	991896.78	15.71	1003.15	0.48	104.61	20.67	0.26	0.20
37.21.61A	178.32	0.00	0.75	999679.72	5.88	16.45	0.01	87.73	0.57	0.01	0.16
36.21.60A	1387.97	0.00	0.70	726459.80	496.95	216.27	0.43	94.63	21.24	1.25	5.38
37.21.62	930.29	0.00	0.09	997237.32	11.84	1396.12	0.06	88.07	120.57	0.23	0.00
37.21.62	1409.88	0.00	1.35	996906.63	8.19	974.43	0.00	74.43	418.34	0.07	0.00
26.21.04C1.11	0.00	0.00	0.00	999668.34	0.00	65.19	0.00	105.30	138.05	0.00	0.00
26.21.04C1.20	0.00	47.51	0.00	999295.05	1.69	431.73	0.00	107.05	51.68	0.12	0.07
26.21.04C1.24	0.00	0.00	0.00	999808.20	0.00	26.95	0.00	65.99	79.17	0.00	0.01
26.21.04C1.27	0.00	13.30	0.00	999779.72	0.00	0.06	0.00	69.70	127.33	0.00	0.00
26.21.04C1.30	0.00	0.00	0.00	999762.03	0.00	0.00	0.00	99.30	129.77	0.00	0.04
26.21.04C1.8	0.00	0.00	0.00	999624.29	0.00	195.74	0.00	69.56	37.12	0.00	0.02
34.21.34BA	0.00	0.00	0.00	999358.23	0.00	0.00	0.00	186.60	254.59	0.00	1.08
34.21.34BAa	97.08	96.36	0.24	999602.71	22.37	70.80	0.01	18.15	72.66	0.07	0.07
34.21.34BAb	525.96	491.74	1.59	998362.85	65.25	86.60	0.16	27.07	380.62	0.29	0.22
34.21.34BAc	218.71	199.28	0.69	999342.39	36.69	42.86	0.06	18.24	123.80	0.09	0.14
34.21.34CA	299.91	19.67	2.08	999462.32	0.14	79.21	0.00	79.06	9.49	0.21	0.00
34.21.66A	0.00	0.00	0.00	999743.43	40.48	8.68	0.00	88.25	103.19	0.11	0.02
34.21.66B	0.00	4.31	0.04	999407.30	17.29	50.26	0.05	82.38	14.52	0.01	0.06
34.21.66C	669.68	0.00	0.97	998400.25	13.23	56.56	0.10	73.58	45.28	0.00	0.01

Copper Trace Element Data: Iron through Indium

Sample No.	Fe	Ni	Co	Cu	Zn	As	Mo	Rh	Ag	Cd	In
34.21.66D	1043.78	0.00	0.60	998129.06	18.93	53.25	0.03	74.84	287.81	0.04	0.00
34.21.66E	0.00	0.00	0.00	999800.61	3.29	23.09	0.02	78.78	60.67	0.02	0.00
34.21.66F	928.46	8.46	0.00	998325.09	15.24	85.40	0.28	79.82	221.46	0.11	0.00
34.21.66G	603.18	0.00	0.49	998998.57	0.00	7.76	0.06	68.84	92.74	0.00	0.02
34.21.66H	240.96	0.00	0.04	999158.32	8.02	221.71	0.11	87.60	53.13	0.00	0.05
34.21.34AA	16.55	0.00	0.23	999694.44	19.12	29.09	0.14	85.15	90.74	0.05	0.00
34.21.80C	0.00	167.98	0.00	997285.90	0.00	1675.27	0.00	206.93	364.71	0.00	0.00
34.21.80D	0.00	0.00	0.00	999535.09	0.00	9.52	0.00	129.43	146.40	0.00	0.00
34.21.80G	1096.07	0.00	0.54	997149.73	46.58	1482.50	0.00	89.51	79.30	0.01	0.00
34.21.80I	0.00	0.00	0.00	997587.45	34.07	1925.19	0.00	86.34	65.45	0.01	0.04
34.21.80J	0.00	0.00	0.00	997894.47	0.00	1881.88	0.00	107.26	76.82	0.00	0.00
34.21.80K	639.89	0.00	0.00	997034.80	229.42	776.11	0.11	93.64	110.47	1.28	0.17
34.21.80O	0.00	0.00	0.00	993628.28	2.38	5578.42	0.00	112.41	204.53	0.00	0.00
34.21.80R	519.63	0.00	0.00	994446.44	0.00	4618.66	0.00	101.47	142.65	0.00	0.00
34.21.80S	9192.80	0.00	1.82	988430.77	2.31	281.03	0.07	119.70	77.43	0.04	0.00
34.21.80T	0.00	0.00	0.00	999431.73	0.00	91.68	0.00	112.46	272.76	0.00	0.00
28.21.02	464.23	96.14	0.00	998907.50	9.57	14.89	0.05	67.83	264.05	0.07	0.00
28.21.02A	28.39	70.71	0.13	999622.30	193.89	6.07	0.05	24.74	47.85	1.00	0.00
28.21.02B	42.91	729.31	0.37	997811.97	1371.59	5.91	0.15	19.55	7.57	4.54	0.16
28.21.02C	425.51	720.60	1.31	998581.03	142.58	40.38	0.00	30.81	19.29	0.62	0.30
37.21.69B	2731.85	16.48	0.11	994415.72	77.96	2439.95	0.60	94.42	135.32	0.00	0.00
37.21.69C	0.00	37.86	0.00	996716.11	11.80	1342.53	0.00	79.95	54.13	0.00	0.00
37.21.69D	0.00	0.00	0.00	996976.77	0.00	2776.70	0.09	82.16	157.67	0.00	0.00
37.21.69F	38944.57	3740.90	41.50	891082.08	1003.34	1060.55	0.45	53.66	74.20	7.61	0.00
37.21.69G	0.00	0.00	0.00	998305.05	1.22	1519.14	0.03	66.59	61.11	0.00	0.00

Copper Trace Element Data: Tin through Lead

Sample No.	Sn	Sb	Te	La	Ce	Ta	W	Pt	Au	Hg	Pb
51.6B1	0.03	0.10	0.00	0.72	1.44	0.00	0.07	0.02	0.02	0.90	0.39
51.6B1	0.01	0.00	0.00	0.96	2.11	0.00	0.05	0.00	0.01	0.97	0.74
56.7B1	0.10	0.13	0.62	18.87	36.56	0.00	0.02	0.00	0.00	6.53	0.78
56.7B1	0.06	0.00	0.00	68.53	100.71	0.34	0.22	0.00	0.02	4.11	4.35
59.07B4	0.02	0.00	0.00	2.12	4.68	0.00	0.03	0.00	0.00	1.41	0.21
59.07B4	0.02	0.10	0.00	3.44	6.99	0.00	0.12	0.00	0.00	1.44	0.75
62.25B5	0.04	0.00	0.33	4.21	7.04	0.00	0.00	0.03	0.00	4.81	0.79
62.25B5	0.02	0.15	0.10	1.82	4.88	0.00	0.02	0.00	0.08	2.02	0.50
63.6B4	0.00	0.00	0.00	1.18	2.33	0.00	0.04	0.00	0.00	0.00	0.00
63.6B4	0.04	0.08	0.25	4.87	9.56	0.00	0.08	0.00	0.03	2.61	0.63
63.6B4	0.03	0.00	1.48	5.11	7.52	0.00	0.09	0.00	0.01	3.53	0.78
65.26B4	0.00	0.00	0.88	2.10	4.81	0.01	0.04	0.00	0.00	0.46	0.75
66.29B2	0.04	0.00	0.36	2.21	3.44	0.00	0.05	0.00	0.00	1.91	0.52
66.29B2	0.08	0.03	0.43	2.58	3.89	0.00	0.02	0.00	0.00	1.93	0.39
TP10B1	0.05	0.23	0.59	20.30	34.86	0.00	0.03	0.00	0.06	13.68	6.55
TP10B1	0.04	0.00	0.10	4.08	9.46	0.00	0.11	0.00	0.02	7.30	1.51
96E1.254	0.15	0.67	0.67	5.36	8.63	0.02	0.94	0.04	0.05	1.61	7.04
96E1.254	0.04	0.00	0.52	3.41	4.25	0.00	0.01	0.00	0.14	1.27	0.70
96E1.255	0.11	0.25	0.15	0.41	0.51	0.00	0.03	0.00	0.03	1.88	0.14
96E1.265	0.11	1.10	0.50	6.54	9.07	0.01	1.22	0.00	0.01	1.77	7.86
96E1.265	0.05	0.26	0.00	0.34	0.55	0.00	0.07	0.00	0.00	1.83	0.34
96E1.271	0.05	0.45	0.50	2.87	3.45	0.00	0.02	0.00	0.01	1.58	0.74
96E1.271	0.01	0.06	0.66	0.58	0.85	0.00	0.02	0.00	0.02	0.46	0.19
96E1.278	0.06	0.50	0.13	1.40	2.62	0.00	0.04	0.04	0.04	7.18	0.91
96E1.286	0.05	0.36	0.16	5.94	8.96	0.00	0.09	0.00	0.01	1.32	1.77
96E1.286	0.02	0.35	0.00	0.78	1.13	0.00	0.00	0.01	0.03	1.12	0.19
96E1.290	0.03	0.40	0.63	6.29	8.31	0.01	0.11	0.00	0.04	3.33	0.37
96E1.294	0.06	0.14	0.00	1.70	2.60	0.00	0.02	0.00	0.00	1.15	0.38
96E1.294	0.04	0.33	0.00	2.01	2.77	0.00	0.02	0.00	0.00	0.83	0.13
96E1.305	0.04	0.28	0.09	0.20	0.37	0.00	0.15	0.01	0.01	0.87	0.24
96E1.305	0.01	0.13	0.14	0.28	0.45	0.00	0.04	0.00	0.02	0.29	0.14
96E1.309	0.05	0.27	0.28	1.30	1.50	0.00	0.15	0.00	0.00	1.05	0.62

Copper Trace Element Data: Tin through Lead

Sample No.	Sn	Sb	Te	La	Ce	Ta	W	Pt	Au	Hg	Pb
96E1.316	0.30	0.16	1.32	12.12	20.75	0.00	0.16	0.00	0.12	2.70	0.26
96E1.316	0.07	0.57	0.00	14.77	21.05	0.00	0.78	0.00	0.00	2.42	0.29
96E1.318	0.10	0.41	0.23	5.58	6.71	0.00	0.02	0.03	0.19	4.45	0.14
96E1.513	2.75	2.52	3.16	162.54	422.27	2.08	2.41	0.15	0.12	4.01	20.62
96E1.523	0.17	0.18	0.00	1.62	1.92	0.00	0.02	0.00	0.06	4.65	0.32
96E1.523	0.21	0.48	0.00	11.28	15.06	0.00	0.06	0.00	0.58	5.61	0.91
96E1.60	0.09	0.00	0.00	1.09	1.74	0.00	0.04	0.00	0.00	1.10	0.18
96E1.618	0.12	0.17	0.99	18.84	29.09	0.01	0.20	0.00	0.04	2.89	0.36
96E1.653	1.14	0.72	0.00	2.61	3.78	0.00	0.04	0.00	0.06	3.62	0.07
96E1.653	0.03	0.34	0.00	2.40	3.28	0.00	0.06	0.00	0.00	1.59	0.05
96E1.695	0.32	0.47	0.30	1.65	1.68	0.00	0.14	0.00	0.07	0.49	0.11
96E1.695	2.81	0.00	0.00	4.64	6.72	0.00	0.04	0.00	0.00	0.79	0.11
96E1.702	0.10	0.25	0.44	1.86	2.62	0.00	0.00	0.00	0.03	1.43	0.09
Unit B	0.00	0.00	0.23	0.98	1.18	0.02	0.02	0.00	0.00	0.67	0.00
Unit B	0.00	0.00	0.00	1.67	2.03	0.00	0.16	0.00	0.00	1.19	0.17
1743.108	0.00	0.00	0.00	3.71	5.36	0.01	0.02	0.00	0.00	1.28	0.15
1743.108	0.00	0.00	0.00	2.57	3.54	0.00	0.04	0.00	0.00	0.56	0.00
1748.18	0.00	0.00	0.00	1.50	2.07	0.00	0.00	0.00	0.00	0.19	1.15
1748.18	0.00	0.00	0.00	2.94	4.37	0.01	0.02	0.00	0.00	0.00	0.00
1749.55	0.00	0.00	0.00	2.17	3.00	0.01	0.05	0.00	0.00	0.13	0.00
1749.55	0.00	0.00	0.49	8.69	11.33	0.05	0.17	0.00	0.06	0.10	3.76
1749.56	0.00	0.04	0.61	3.92	6.89	0.03	0.06	0.01	0.00	1.66	2.87
1749.56	0.00	0.00	0.28	2.79	4.16	0.00	0.07	0.00	0.00	0.99	0.21
1751.42	0.00	0.00	0.00	1.82	3.34	0.00	0.01	0.01	0.00	0.07	0.16
1751.42	0.00	0.00	0.37	5.58	8.76	0.00	0.01	0.01	0.00	0.24	0.00
1744.147A	0.00	0.00	0.00	4.24	6.88	0.02	0.00	0.01	0.00	1.08	0.36
1744.147A	0.00	0.35	1.36	12.17	19.10	0.05	0.12	0.00	0.00	0.76	0.01
1744.147B	0.00	0.00	0.00	6.84	12.00	0.03	0.24	0.00	0.00	1.24	0.99
1744.147B	0.00	0.00	0.46	4.22	9.18	0.02	0.07	0.01	0.00	0.58	0.00
1744.147C	0.00	0.00	0.48	5.52	11.14	0.00	0.08	0.00	0.00	0.47	0.16
1744.147C	0.00	0.00	0.00	6.10	11.16	0.02	0.01	0.00	0.00	0.19	0.00
1744.147D	0.00	0.24	0.34	8.18	14.21	0.02	0.07	0.00	0.00	0.14	1.06
1744.147D	0.00	0.00	0.05	8.77	14.36	0.03	0.09	0.00	0.00	0.42	0.36

Copper Trace Element Data: Tin through Lead

Sample No.	Sn	Sb	Te	La	Ce	Ta	W	Pt	Au	Hg	Pb
1744.147E	0.00	0.00	0.16	3.28	5.00	0.00	0.01	0.00	0.00	0.47	0.26
1744.147E	0.00	0.00	0.44	2.83	3.95	0.01	0.00	0.00	0.00	0.62	0.00
RghB13A	0.00	0.00	0.77	4.54	4.24	0.05	0.15	0.04	0.00	10.86	1710.80
RghB13A	0.00	0.00	0.16	0.20	0.11	0.00	0.00	0.05	0.00	7.98	28.51
RghB13A	0.00	0.00	2.50	0.06	0.07	0.00	0.00	0.00	0.00	5.88	0.00
RghB13B	0.00	0.00	0.00	0.06	0.01	0.00	0.00	0.06	0.00	15.86	0.00
RghB13B	0.00	0.00	0.81	0.14	0.04	0.00	0.01	0.02	0.07	37.80	4.71
RghB13C	0.00	0.01	0.00	0.27	0.21	0.00	0.00	0.00	0.00	5.47	370.44
RghB13C	0.00	0.00	0.19	1.13	0.53	0.00	0.03	0.05	0.00	6.89	10.94
RghB13D	0.00	0.00	0.00	1.97	1.00	0.00	0.03	0.01	0.00	4.93	68.72
RghB13D	0.02	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.59	2.55
RghB13E	0.00	12.07	0.00	0.55	0.38	0.00	0.00	0.00	0.00	3.38	0.82
RghB13E	0.03	9.51	0.26	0.01	0.00	0.00	0.00	0.02	0.00	1.17	1.01
RghB13F	0.01	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.03	2.61	5.11
RghB13F	0.04	0.34	1.98	0.16	0.11	0.00	0.00	0.09	0.01	2.89	178.51
RghB13G	0.01	1.18	0.40	0.22	0.14	0.02	0.00	0.02	0.03	7.09	2.13
RghB13G	0.07	0.84	1.58	0.19	0.29	0.01	0.00	0.00	0.06	4.69	8.77
RghB13H	0.06	0.46	0.74	0.06	0.05	0.00	0.00	0.01	0.09	10.55	17.87
RghB13H	0.15	0.43	0.52	0.79	0.80	0.02	0.05	0.10	0.02	11.48	281.20
RghB13I	0.04	0.83	1.96	0.06	0.03	0.00	0.03	0.00	0.08	5.15	1.26
RghB13I	0.00	1.03	0.65	0.03	0.04	0.01	0.00	0.00	0.00	0.77	0.00
RghB13J	0.03	0.76	0.41	0.05	0.02	0.00	0.00	0.02	0.17	6.41	22.31
RghB13J	0.08	1.36	1.31	0.20	0.11	0.00	0.01	0.20	0.08	4.03	1.97
RghB13K	0.06	0.67	0.48	0.15	0.09	0.00	0.02	0.03	0.12	19.56	182.79
RghB13K	0.03	0.77	0.45	0.02	0.02	0.00	0.00	0.03	0.01	0.47	8.97
RghB13L	0.06	0.51	0.00	0.90	1.18	0.09	0.03	0.01	0.00	1.09	257.54
RghB13L	0.13	1.46	0.71	0.04	0.05	0.02	0.04	0.00	0.00	1.27	4.03
RghB13L	0.05	3.05	0.00	0.12	0.10	0.00	0.00	0.18	0.24	34.21	170.39
RghB18	0.04	0.30	0.19	0.18	0.15	0.01	0.02	0.00	0.02	1.69	1.56
RghB18	0.08	0.87	0.29	0.23	0.18	0.00	0.04	0.00	0.02	4.98	5.23
RghB23	0.08	0.01	0.00	0.27	0.21	0.00	0.10	0.12	0.05	6.01	14.05
RghB23	0.71	2.27	0.00	1.66	2.48	0.00	0.10	0.02	0.02	2.48	220.24
RvF13A	0.26	14.49	0.22	0.50	1.04	0.02	0.65	0.01	0.02	1.67	30.18

Copper Trace Element Data: Tin through Lead

Sample No.	Sn	Sb	Te	La	Ce	Ta	W	Pt	Au	Hg	Pb
RvF13A	0.05	13.80	0.00	0.53	0.78	0.00	0.00	0.00	0.00	2.91	7.72
RvF13B	0.02	0.67	0.00	0.04	0.05	0.00	0.02	0.01	0.00	0.61	1.15
RvF13B	0.06	1.80	2.51	1.13	1.60	0.04	0.18	0.00	0.05	2.91	9.17
RvF13C	0.07	13.36	0.00	0.58	0.85	0.03	0.03	0.04	0.04	3.39	67.80
RvF13C	0.19	9.83	0.00	1.12	1.47	0.01	0.12	0.00	0.00	1.46	12.64
RvF13D	0.08	1.31	0.08	0.17	0.31	0.00	0.03	0.00	0.01	0.98	28.92
RvF13D	0.02	0.56	0.17	0.08	0.11	0.01	0.00	0.00	0.03	0.97	3.48
RvF13E	1.05	10.25	7.36	0.69	1.15	0.00	0.40	0.00	0.40	6.43	89.71
RvF13E	0.09	3.98	1.67	1.26	1.43	0.02	0.02	0.00	0.06	3.02	16.81
RvF13F	0.18	1.79	0.05	1.12	1.99	0.03	0.19	0.04	0.00	1.58	22.15
RvF13F	0.07	0.58	0.00	0.12	0.18	0.00	0.00	0.00	0.00	0.33	16.00
RvF13H	0.01	0.85	1.47	0.28	0.44	0.02	0.00	0.00	0.00	0.25	2.05
RvF13H	0.26	1.38	2.86	0.07	0.15	0.00	0.05	0.04	0.00	0.45	4.43
RvF13I	0.11	2.27	0.18	0.95	1.68	0.01	0.08	0.00	0.00	0.12	15.29
RvF13I	0.00	0.78	0.23	0.04	0.13	0.00	0.03	0.00	0.00	0.50	33.74
RvF13J	0.04	13.22	1.53	0.57	0.67	0.00	0.03	0.00	0.05	0.94	14.45
RvF13J	0.22	5.77	13.61	0.30	0.47	0.03	0.03	0.00	0.34	0.00	13.61
RvF13K	0.07	0.61	3.66	0.08	0.22	0.00	0.04	0.08	0.00	0.21	1.50
RvF13K	0.05	3.92	7.12	0.45	1.06	0.02	0.08	0.16	0.04	0.00	3.33
RvF17A	0.41	0.00	0.00	12.51	11.33	1.10	0.96	0.84	0.49	101.81	12.84
RvF17A	0.19	2.82	0.65	1.15	0.98	0.01	0.04	0.00	0.00	1.62	4.74
RvF17B	0.13	0.86	0.23	0.55	0.38	0.00	0.03	0.00	0.00	1.51	4.40
RvF17B	0.16	1.13	0.26	2.11	1.64	0.00	0.01	0.00	0.01	1.18	29.74
RvF17C	0.48	5.38	4.17	3.82	2.29	0.01	0.02	0.00	0.00	4.56	8.41
RvF17C	0.25	2.01	3.69	1.74	2.34	0.00	0.04	0.01	0.02	5.11	8.19
RvF17D	0.16	0.83	0.61	0.11	0.22	0.00	0.00	0.00	0.00	0.15	5.91
RvF17D	0.29	3.11	0.30	40.57	36.73	0.00	0.05	0.01	0.00	3.12	32.15
RvF17E	1.51	3.37	6.83	1.35	1.30	0.03	0.22	0.02	0.00	0.33	20.56
RvF17E	22.91	117.85	1541.30	0.00	11.52	0.00	0.00	46.88	0.00	0.00	18.08
RvF17F	0.36	2.30	0.63	1.45	1.14	0.00	0.06	0.00	0.13	1.74	15.60
RvF17F	1.05	1.05	0.34	0.59	0.54	0.01	0.00	0.00	0.00	1.53	77.47
RvF17G	0.05	2.33	0.09	0.26	0.28	0.00	0.01	0.00	0.01	0.51	1.13
RvF17G	0.39	1.09	0.40	1.13	1.04	0.00	0.05	0.00	0.01	0.29	3.30

Copper Trace Element Data: Tin through Lead

Sample No.	Sn	Sb	Te	La	Ce	Ta	W	Pt	Au	Hg	Pb
RvF1G	0.00	2.62	2.33	0.18	0.35	0.02	0.08	0.00	0.00	0.68	13.04
RvF1G	0.06	1.10	0.33	0.20	0.28	0.01	0.04	0.00	0.00	0.49	2.65
RvF27	0.20	1.66	0.56	0.20	0.44	0.01	0.01	0.08	0.24	8.04	34.25
RvF27	0.32	1.20	0.97	0.21	0.36	0.00	0.00	0.00	0.09	7.17	42.24
RvF29A	0.03	0.11	0.00	0.04	0.08	0.00	0.00	0.08	0.00	6.49	0.58
RvF29A	0.13	0.45	2.29	0.17	0.13	0.00	0.00	0.00	0.00	6.82	3.62
RvF29B	0.22	1.64	0.00	0.62	0.62	0.03	0.00	0.00	0.17	73.23	4.91
RvF29B	0.03	0.23	0.14	0.08	0.08	0.00	0.02	0.01	0.02	6.41	15.81
RvF37A	0.11	0.58	0.00	0.41	0.28	0.02	0.63	0.00	0.00	0.00	28.96
RvF37A	109.02	518.07	566.52	0.20	25.68	0.00	5.11	0.00	0.00	0.00	36.53
RvF37A	0.02	0.61	0.00	0.15	0.19	0.00	0.02	0.00	0.01	0.45	33.68
RvF37B	0.29	3.43	3.11	0.32	0.40	0.01	0.00	0.00	0.00	0.00	446.38
RvF37B	0.03	0.33	0.16	0.33	0.33	0.01	0.02	0.00	0.00	1.10	78.09
RvF37C	0.21	1.35	1.15	0.24	0.17	0.00	0.04	0.00	0.02	0.00	49.59
RvF37C	0.03	0.31	0.00	0.10	0.18	0.00	0.01	0.00	0.00	0.32	11.39
RvF37D	92.34	949.15	0.00	23.17	11.30	0.00	30.09	0.00	0.00	0.00	34.11
RvF37D	0.09	0.67	0.00	0.19	0.19	0.02	0.01	0.00	0.00	1.38	11.01
RvF37D	0.85	0.80	0.00	0.14	0.20	0.01	0.00	0.00	0.00	0.92	41.99
RvF37E	0.09	0.88	0.69	0.02	0.02	0.00	0.00	0.00	0.00	0.00	23.34
RvF37E	0.01	0.67	0.00	0.08	0.07	0.00	0.00	0.00	0.00	0.92	20.06
RvF37F	0.07	0.85	0.39	1.13	0.68	0.00	0.00	0.00	0.00	0.08	74.04
RvF37F	0.01	6.54	3.12	1.05	1.63	0.07	0.15	0.00	0.02	0.78	122.62
RvF37G	0.06	0.93	2.31	0.11	0.06	0.00	0.02	0.00	0.00	0.00	9.10
RvF37G	0.00	0.77	4.18	0.13	0.18	0.01	0.02	0.00	0.00	1.02	84.67
RvF37H	0.47	1.44	1.62	0.15	0.13	0.00	0.01	0.05	0.05	34.47	124.99
RvF37H	0.04	2.16	4.17	2.27	1.76	0.01	0.00	0.00	0.02	4.19	542.06
RvF37I	0.07	0.59	0.67	0.25	0.33	0.00	0.03	0.00	0.00	1.42	27.82
RvF37I	0.04	1.01	0.74	0.40	0.46	0.02	0.01	0.00	0.00	2.14	13.55
RvF37J	0.13	0.31	0.31	0.04	0.04	0.00	0.02	0.01	0.02	0.00	30.66
RvF37J	0.06	3.65	14.28	0.42	0.45	0.01	0.00	0.00	0.09	3.25	56.37
RvF37K	0.13	1.14	0.56	0.77	0.57	0.01	0.04	0.02	0.12	0.00	64.09
RvF37K	0.05	1.51	0.00	0.24	0.41	0.00	0.00	0.00	0.00	0.61	48.09
RvF37L	0.14	1.44	0.33	0.08	0.13	0.00	0.02	0.00	0.00	0.00	83.81

Copper Trace Element Data: Tin through Lead

Sample No.	Sn	Sb	Te	La	Ce	Ta	W	Pt	Au	Hg	Pb
RvF37L	0.25	1.93	0.77	0.22	0.37	0.00	0.00	0.06	0.11	4.82	154.29
RvF37L	0.08	2.01	2.33	0.32	0.29	0.00	0.01	0.00	0.08	88.64	45.33
RvF37M	0.32	1.23	7.16	0.05	0.06	0.01	0.00	0.00	0.00	0.00	53.94
RvF37M	0.30	1.76	1.18	0.37	0.42	0.00	0.00	0.00	0.04	1.47	113.96
RvF37N	14.22	329.76	473.64	0.00	29.94	7.83	0.00	0.00	5.59	0.00	18.41
RvF37N	0.06	1.58	1.95	0.14	0.17	0.01	0.00	0.00	0.00	1.52	6.16
RvF37N	0.08	1.30	0.00	0.12	0.16	0.00	0.00	0.00	0.00	1.91	76.04
RvF43	0.22	6.32	2.77	1.45	1.89	0.00	0.02	0.13	0.23	241.31	128.81
RvF43	0.28	4.20	0.22	3.20	3.51	0.09	0.70	0.04	0.07	110.54	97.93
Th50787	0.11	2.70	2.87	0.41	0.51	0.05	0.00	0.08	0.00	0.00	18509.92
Th50787	0.09	7.97	5.43	0.37	0.35	0.00	0.02	0.00	0.06	0.00	23818.58
Th50790A	0.05	0.37	0.34	0.02	0.04	0.00	0.00	0.00	0.00	0.00	44.65
Th50790A	0.05	1.33	2.81	0.03	0.05	0.02	0.00	0.02	0.00	0.00	9.72
Th50790B	0.24	2.12	10.96	0.40	0.44	0.02	0.00	0.00	0.00	0.00	18.64
Th50790B	0.18	3.99	2.30	0.20	0.39	0.06	0.01	0.15	0.00	0.00	232.81
23.21.50A	0.67	0.00	0.00	0.34	1.83	0.12	2.88	0.42	0.26	43.19	71.70
23.21.50Ab	7.34	5.91	0.68	67.32	28.48	0.00	3.50	0.04	2.63	106.90	704.68
23.21.51A	1.28	2.55	8.89	0.00	0.03	0.00	0.37	0.00	0.00	1.50	0.70
34.21.37E	2.82	5.68	0.00	1.24	3.11	0.83	0.79	0.00	0.35	15.61	150.38
34.21.37J	0.16	0.00	0.00	3.22	10.15	0.05	0.04	0.00	0.02	1.14	2.53
34.21.37NA	0.00	1.20	0.21	0.03	0.15	0.01	0.03	0.00	0.00	0.47	0.97
34.21.37NB	0.00	0.18	0.74	0.06	0.48	0.01	0.02	0.00	0.00	0.45	1.01
34.21.37NC	0.90	2.58	0.02	0.15	0.69	0.01	0.32	0.03	0.08	1.21	9.85
34.21.37P	0.17	0.00	0.00	0.05	0.32	0.02	0.08	0.08	0.01	1.75	1.79
34.21.45B	0.00	1.15	5.62	0.04	0.05	0.01	0.20	0.00	0.05	17.53	0.46
34.21.45C	0.15	0.54	0.00	0.10	0.43	0.05	0.39	0.00	0.00	4.65	0.43
34.21.45D	8.39	0.43	0.00	0.01	0.05	0.00	0.35	0.00	0.00	6.22	1.74
34.21.45E	0.00	0.00	6.13	0.10	0.14	0.00	0.66	0.00	0.00	14.75	0.37
34.21.45G	1.07	6.03	1.12	0.04	0.19	0.00	0.23	0.00	0.06	4.21	5.73
34.21.45H	0.84	27.74	0.00	0.06	0.31	0.01	0.82	0.00	0.00	1.89	3.34
34.21.45I	0.00	1.25	0.00	0.00	0.04	0.00	0.38	0.00	0.00	1.23	0.00
34.21.45J	0.00	2.84	0.62	0.09	0.20	0.00	0.07	0.06	0.08	2.45	1.04
34.21.45K	1.05	1.69	1.70	0.01	0.03	0.01	0.07	0.00	0.04	0.98	0.47

Copper Trace Element Data: Tin through Lead

Sample No.	Sn	Sb	Te	La	Ce	Ta	W	Pt	Au	Hg	Pb
34.21.45L	0.40	4.44	1.54	9.22	34.92	0.03	0.34	0.00	0.00	1.34	0.39
37.21.61A	0.00	0.28	3.36	0.00	0.07	0.02	0.10	0.00	0.07	4.14	1.88
36.21.60A	0.26	22.89	11.51	2939.72	2119.79	0.33	6.24	1.19	1.90	7.95	259065.68
37.21.62	1.23	0.15	3.43	0.07	0.19	0.01	0.04	0.07	0.06	4.33	2.49
37.21.62	0.00	0.25	0.80	0.00	0.00	0.00	0.00	0.06	0.00	1.07	0.21
26.21.04C1.11	0.12	0.46	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.35	4.01
26.21.04C1.20	0.00	0.00	0.58	0.00	0.07	0.01	0.00	0.00	0.00	2.38	0.38
26.21.04C1.24	0.01	0.40	0.00	0.00	0.00	0.01	0.43	0.06	0.00	0.46	6.67
26.21.04C1.27	0.00	0.53	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.47	2.24
26.21.04C1.30	0.00	1.70	0.00	0.01	0.10	0.04	0.08	0.07	0.00	0.71	0.29
26.21.04C1.8	0.13	0.51	0.00	0.02	0.18	0.01	0.17	0.00	0.00	0.62	0.71
34.21.34BA	0.00	0.00	0.00	0.00	0.06	0.13	8.57	0.00	1.50	27.85	0.99
34.21.34BAa	0.54	1.60	0.10	0.08	0.04	0.00	0.00	0.02	0.01	10.16	0.80
34.21.34BAb	0.37	2.57	3.50	0.28	0.22	0.00	0.13	0.11	0.19	25.26	1.39
34.21.34BAc	0.17	0.97	0.28	0.07	0.17	0.00	0.00	0.00	0.02	5.08	0.50
34.21.34CA	0.23	0.42	0.00	0.12	2.23	0.02	0.00	0.00	0.00	1.24	1.88
34.21.66A	0.19	0.00	0.64	0.01	0.29	0.00	0.00	0.05	0.06	2.30	1.89
34.21.66B	0.22	2.45	0.53	0.53	1.55	0.01	0.04	0.00	0.00	0.48	0.19
34.21.66C	3.68	0.32	0.00	1.99	5.01	0.10	0.25	0.14	0.00	0.64	1.07
34.21.66D	0.52	10.45	0.00	0.00	0.04	0.00	0.06	0.00	0.01	0.92	53.42
34.21.66E	0.00	0.09	1.49	0.01	0.06	0.00	0.00	0.09	0.01	0.57	0.13
34.21.66F	0.45	4.78	0.62	0.16	0.69	0.00	0.29	0.04	0.04	1.17	47.20
34.21.66G	0.00	0.20	0.00	0.00	0.03	0.00	0.00	0.00	0.02	0.66	0.10
34.21.66H	0.00	0.00	0.00	0.07	0.94	0.02	0.18	0.00	0.00	0.94	2.53
34.21.34AA	0.62	7.65	0.00	0.02	0.07	0.00	0.09	0.17	0.62	3.88	30.14
34.21.80C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.07	10.64
34.21.80D	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	2.20	0.61
34.21.80G	0.05	2.70	0.00	0.22	0.97	0.01	0.00	0.00	0.00	1.37	1.75
34.21.80I	0.13	0.49	0.00	0.33	0.98	0.03	0.00	0.02	0.17	2.99	12.69
34.21.80J	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.02	1.97	0.80
34.21.80K	49.17	0.11	3.06	0.09	0.80	0.00	8.41	0.00	0.00	7.19	11.44
34.21.80O	0.06	0.00	0.00	0.69	3.27	0.18	0.00	0.06	0.00	1.68	5.68
34.21.80R	0.00	0.00	0.00	0.09	1.14	0.00	0.00	0.00	0.01	0.48	4.83

Copper Trace Element Data: Tin through Lead

Sample No.	Sn	Sb	Te	La	Ce	Ta	W	Pt	Au	Hg	Pb
34.21.80S	1.49	0.00	0.00	7.44	23.86	0.23	0.17	0.00	0.00	0.88	8.74
34.21.80T	2.05	0.00	0.00	0.15	0.37	0.02	0.00	0.00	0.00	1.28	2.33
28.21.02	0.05	0.64	1.02	0.01	0.02	0.00	0.09	0.02	0.00	0.63	0.45
28.21.02A	0.07	0.11	0.82	0.44	0.13	0.00	0.01	0.00	0.00	0.80	0.15
28.21.02B	0.06	0.26	1.13	0.14	0.02	0.00	0.00	0.00	0.01	0.98	0.25
28.21.02C	0.29	2.36	5.08	0.41	0.15	0.00	0.07	0.00	0.00	7.30	0.37
37.21.69B	0.37	0.44	1.55	0.00	0.08	0.03	0.29	0.00	0.02	1.04	13.78
37.21.69C	0.08	1.67	0.00	0.15	0.37	0.00	0.11	0.00	0.09	0.28	16.17
37.21.69D	0.00	0.04	0.00	0.00	0.01	0.02	0.04	0.11	0.02	0.59	0.00
37.21.69F	0.00	3.04	0.00	2.34	22.65	0.00	3.48	0.00	0.00	30.99	2494.25
37.21.69G	0.05	0.00	0.00	0.15	0.08	0.00	0.01	0.00	0.01	3.11	5.70

Copper Trace Element Data: Bismuth and Uranium

Sample No.	Bi	U
51.6B1	0.04	4.50
51.6B1	0.01	5.35
56.7B1	0.03	37.11
56.7B1	0.07	63.74
59.07B4	0.01	5.85
59.07B4	0.00	12.19
62.25B5	0.01	4.31
62.25B5	0.01	7.08
63.6B4	0.00	5.21
63.6B4	0.01	3.43
63.6B4	0.00	2.62
65.26B4	0.00	11.88
66.29B2	0.07	3.54
66.29B2	0.03	3.03
TP10B1	0.05	10.61
TP10B1	0.03	6.77
96E1.254	0.04	12.67
96E1.254	0.01	2.60

Copper Trace Element Data: Bismuth and Uranium

Sample No.	Bi	U
96E1.255	0.01	2.76
96E1.265	0.07	172.15
96E1.265	0.05	5.28
96E1.271	0.09	3.08
96E1.271	0.01	0.17
96E1.278	0.02	2.96
96E1.286	0.13	27.03
96E1.286	0.04	1.26
96E1.290	0.03	14.04
96E1.294	0.03	1.45
96E1.294	0.02	1.15
96E1.305	0.00	1.85
96E1.305	0.01	0.50
96E1.309	0.02	2.30
96E1.316	0.05	14.41
96E1.316	0.14	7.13
96E1.318	1.44	3.40
96E1.513	7.85	3298.83
96E1.523	0.01	0.82
96E1.523	0.53	3.18
96E1.60	0.00	0.62
96E1.618	0.04	30.14
96E1.653	0.01	0.57
96E1.653	0.01	0.67
96E1.695	0.00	2.61
96E1.695	0.03	1.30
96E1.702	0.85	11.05
Unit B	0.00	1.07
Unit B	0.00	2.61
1743.108	0.00	4.78
1743.108	0.00	3.61
1748.18	0.00	1.92
1748.18	0.00	2.48
1749.55	0.00	2.64

Copper Trace Element Data: Bismuth and Uranium

Sample No.	Bi	U
1749.55	0.00	14.57
1749.56	0.00	8.78
1749.56	0.00	5.14
1751.42	0.00	29.11
1751.42	0.00	18.91
1744.147A	0.00	6.87
1744.147A	0.00	17.36
1744.147B	0.00	20.59
1744.147B	0.00	9.83
1744.147C	0.00	12.02
1744.147C	0.00	6.86
1744.147D	0.08	14.20
1744.147D	0.00	13.36
1744.147E	0.00	6.49
1744.147E	0.00	5.17
RghB13A	1.34	20.83
RghB13A	0.00	3.97
RghB13A	0.00	0.23
RghB13B	0.00	1.63
RghB13B	0.00	9.69
RghB13C	0.12	9.99
RghB13C	0.00	9.16
RghB13D	0.02	11.42
RghB13D	0.00	0.38
RghB13E	0.08	0.17
RghB13E	0.08	0.06
RghB13F	0.01	0.06
RghB13F	0.30	1.14
RghB13G	0.01	0.35
RghB13G	0.04	0.98
RghB13H	0.04	1.52
RghB13H	0.36	6.35
RghB13I	0.01	0.25
RghB13I	0.00	0.09

Copper Trace Element Data: Bismuth and Uranium

Sample No.	Bi	U
RghB13J	0.04	0.84
RghB13J	0.02	0.84
RghB13K	0.20	2.38
RghB13K	0.02	0.66
RghB13L	0.31	0.40
RghB13L	0.02	0.46
RghB13L	0.27	3.29
RghB18	0.00	0.82
RghB18	0.01	1.04
RghB23	0.10	0.66
RghB23	2.20	0.50
RvF13A	0.62	3.24
RvF13A	0.09	2.86
RvF13B	0.01	1.19
RvF13B	0.12	6.35
RvF13C	0.20	9.79
RvF13C	0.40	2.64
RvF13D	0.24	1.65
RvF13D	0.05	0.81
RvF13E	1.24	4.88
RvF13E	0.59	7.55
RvF13F	0.16	4.16
RvF13F	0.24	0.89
RvF13H	0.04	2.17
RvF13H	0.03	0.11
RvF13I	0.19	6.20
RvF13I	1.47	1.01
RvF13J	0.02	6.26
RvF13J	0.05	17.48
RvF13K	0.00	0.42
RvF13K	0.01	4.87
RvF17A	0.33	44.35
RvF17A	0.03	3.95
RvF17B	0.06	1.15

Copper Trace Element Data: Bismuth and Uranium

Sample No.	Bi	U
RvF17B	0.29	0.74
RvF17C	0.06	14.35
RvF17C	0.07	0.84
RvF17D	0.01	1.00
RvF17D	0.06	6.03
RvF17E	0.06	5.82
RvF17E	7.19	431.43
RvF17F	0.10	6.30
RvF17F	0.67	1.71
RvF17G	0.01	2.00
RvF17G	0.03	2.15
RvF1G	0.10	1.98
RvF1G	0.03	2.61
RvF27	0.04	2.32
RvF27	0.97	2.25
RvF29A	0.02	1.64
RvF29A	0.09	7.83
RvF29B	0.05	3.41
RvF29B	0.03	2.73
RvF37A	0.08	1.28
RvF37A	7.56	0.00
RvF37A	0.35	0.28
RvF37B	0.98	6.70
RvF37B	2.25	0.48
RvF37C	0.05	0.42
RvF37C	0.02	1.83
RvF37D	22.80	0.00
RvF37D	0.02	0.72
RvF37D	0.07	0.45
RvF37E	0.08	0.19
RvF37E	0.38	0.20
RvF37F	1.82	1.21
RvF37F	0.16	4.78
RvF37G	0.03	1.17

Copper Trace Element Data: Bismuth and Uranium

Sample No.	Bi	U
RvF37G	0.08	0.30
RvF37H	0.95	0.64
RvF37H	0.54	1.08
RvF37I	0.21	1.00
RvF37I	0.10	0.79
RvF37J	0.16	1.28
RvF37J	0.49	0.12
RvF37K	0.39	2.23
RvF37K	0.05	1.63
RvF37L	0.52	0.48
RvF37L	0.80	0.67
RvF37L	0.06	0.38
RvF37M	0.14	0.26
RvF37M	0.14	0.51
RvF37N	0.64	0.00
RvF37N	0.01	0.18
RvF37N	1.64	0.43
RvF43	0.15	4.16
RvF43	0.15	15.17
Th50787	9.06	1.12
Th50787	12.53	0.43
Th50790A	0.66	0.23
Th50790A	0.01	0.27
Th50790B	0.07	0.78
Th50790B	0.36	2.56
23.21.50A	4.12	145.67
23.21.50Ab	20.89	331.24
23.21.51A	0.76	0.00
34.21.37E	6.47	42.60
34.21.37J	0.07	7.91
34.21.37NA	0.00	0.75
34.21.37NB	0.00	1.21
34.21.37NC	0.04	4.99
34.21.37P	0.02	0.43

Copper Trace Element Data: Bismuth and Uranium

Sample No.	Bi	U
34.21.45B	0.01	0.89
34.21.45C	0.04	0.92
34.21.45D	0.02	0.49
34.21.45E	0.12	0.48
34.21.45G	0.05	2.29
34.21.45H	0.11	3.17
34.21.45I	0.01	0.39
34.21.45J	0.07	16.20
34.21.45K	0.01	0.38
34.21.45L	5.02	25.92
37.21.61A	0.35	0.78
36.21.60A	323.68	1368.17
37.21.62	0.01	0.38
37.21.62	0.00	0.00
26.21.04C1.11	0.03	0.00
26.21.04C1.20	0.01	17.95
26.21.04C1.24	0.39	0.79
26.21.04C1.27	0.00	0.50
26.21.04C1.30	0.09	0.23
26.21.04C1.8	0.00	36.97
34.21.34BA	0.01	0.69
34.21.34BAa	0.01	0.00
34.21.34BAb	0.05	0.21
34.21.34BAc	0.01	0.00
34.21.34CA	0.03	0.26
34.21.66A	0.04	0.63
34.21.66B	0.04	13.23
34.21.66C	0.06	59.60
34.21.66D	0.34	10.84
34.21.66E	0.02	0.73
34.21.66F	0.36	10.70
34.21.66G	0.00	0.48
34.21.66H	0.00	6.11
34.21.34AA	0.78	0.04

Copper Trace Element Data: Bismuth and Uranium

Sample No.	Bi	U
34.21.80C	0.11	0.00
34.21.80D	0.07	6.09
34.21.80G	0.01	0.00
34.21.80I	0.04	0.59
34.21.80J	0.04	0.00
34.21.80K	0.08	0.00
34.21.80O	0.01	3.85
34.21.80R	0.02	0.00
34.21.80S	0.13	5.55
34.21.80T	0.00	0.00
28.21.02	0.15	0.35
28.21.02A	0.09	0.15
28.21.02B	0.11	0.01
28.21.02C	0.17	0.00
37.21.69B	0.07	0.27
37.21.69C	0.08	3.86
37.21.69D	0.01	0.28
37.21.69F	109.15	139.96
37.21.69G	0.01	0.06