May 2019

Community Identity, Culinary Traditions and Foodways in the Western Great Lakes

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COMMUNITY IDENTITY, CULINARY TRADITIONS AND FOODWAYS IN THE WESTERN GREAT LAKES

by

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A Dissertation Submitted in

Partial Fulfillment of the

Requirements for the Degree of

Doctor of Philosophy

in Anthropology

at

The University of Wisconsin-Milwaukee

May 2019

ABSTRACT

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by

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The University of Wisconsin-Milwaukee, 2019
Under the Supervision of Professor John D. Richards

This dissertation project examines for evidence of substantial differences in community and community identity, as expressed through culinary traditions and foodways, of Early and Middle Woodland populations in the western Great Lakes region from circa 100 BC to AD 400. The research compares culinary traditions and foodways of Early and Middle Woodland populations in southeastern Wisconsin using multiple lines of fined grained material data derived from the Finch site (47JE0902). As an open air Early to Middle Woodland (ca 100 BC to AD 400) domestic habitation, the Finch site serves as a case study for elucidating culinary traditions and foodways at the community level. Implementing a multi-faceted approach, this study integrates traditional plant macrobotanical studies, faunal analyses, ceramic morphological and use wear analyses, and absorbed chemical residue analyses to provide a comprehensive overview of the intersection between food and community in this region of North America.

The results of the study indicate overall similarities in culinary traditions and foodways of Early and Middle Woodland populations. The archaeological data reveal little evidence suggesting that what is archaeologically recognized as Early and Middle Woodland correlate with distinct communities. Based on the Finch site culinary traditions and foodways, groups in the southeastern Wisconsin region of the western Great Lakes did not become fully embedded within a broader Havana Hopewellian relational or symbolic community. The social processes at play in southeastern Wisconsin during the Early and Middle Woodland are distinct from those processes occurring elsewhere in the Havana Hopewellian world, undoubtedly a factor in

community identity formation and transformation within this region of the western Great Lakes. The study underscores the importance and utility of incorporating multiple lines of material evidence to address archaeological research questions and challenges the current taxonomic classification schema for southeastern Wisconsin.

Dedicated to my mother,
Evelina Clara Marie Bird Haas,
and the original “Doc” Haas, my dad, Richard

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> *..in a little old cemetery on highway 26, the road between Fort Atkinson and Koshkonong. The road cuts through the cemetery. On the east side of the road there is a small pond.....and the graves are just the opposite, on the other side of the pavement* [Brown 1937].

The impetus for this research project occurred just over ten years ago, when I investigated the report of an early historic cemetery believed to be the family burial plot of the notorious Fighting Finches. Although the cemetery would be found much later on (another story), early on the search for cemetery led to the discovery of an important prehistoric habitation site, the Finch site. If the Finch site served as the motivation for this dissertation research project, my family and colleagues provided the logistical and professional support required for its successful completion. Throughout the pursuit of my doctorate, my mom and dad (Evelina & Richard) provided unlimited logistical and emotional support, helping with my daughters, dinners, housework, yardwork, and dog walking, all the while championing my decision to simultaneously pursue an academic degree while working full time. My daughters, Rachel and Katie, are commended for their understanding and general good nature that allowed me to devote time to this project.

Professionally, I am ever thankful to my colleague Richard Kubicek, not only for the endless hours of listening to me talk about the Finch site, but also for his excellent field and laboratory skills as the Finch site field and lab director, resulting in the production of an exceptional archaeological data set. I also thank Nicholas Weber for his enormous contribution to the Finch site GIS model and Zachary Stencil for his comprehensive analysis of the Finch site faunal assemblage. Much thanks also is extended to my good friend and running partner, Katherine Shillinglaw, for all those long runs that I was able discuss and sort out my ideas for this dissertation.

I am deeply indebted to my advisor and mentor, Dr. John Richards; thank you for your support, encouragement, and providing direction over these past several years. A sincere thank you is also extended to Dr. Patricia Richards; you have blazed the trail in academia and in business, and I am lucky to have you as a role model and mentor. Thanks is also extended to the other members of my committee: Dr. William Green, Dr. Jean Hudson, and Dr. Robert Jeske, for their advice, attention, and constructive feed back. I am also grateful for Dr. James M. Skibo for taking the time to review (in-person) the Finch ceramic assemblage and providing valuable insights regarding use wear. There are countless others that have contributed in no small way to the success of this project, thank you to all of my friends, colleagues, and family for your love and support over these past seven years. Finally, I would be remiss if I did not extend my most sincere gratitude to my husband, Mark, of whom I cherish and is my most ardent supporter. Without you Mark, this project may have never reached fruition.

Jennifer

CHAPTER 1. INTRODUCTION

Introduction

This archaeological research project uses culinary traditions and foodways from the Early and Middle Woodland occupations at the Finch site (47JE0902), a domestic habitation near Lake Koshkonong in southeastern Wisconsin, to examine evidence for substantial differences in community identity of groups occupying the region from circa 100 BC to AD 400 (Figure 1.1). Implementing a community archaeology approach, archaeological materials classed as Early Woodland and Middle Woodland are viewed as the material indicators of distinct communities. An examination of culinary traditions and foodways is then used to test this notion. That Early and Middle Woodland populations reflect different communities is based on current cultural-historical schema and conceptual frameworks (Benchley et al. 1997; Jeske 2006; Mason 1981; Salzer n.d.; Stevenson et al. 1997; Struever 1964). Moreover, what is archaeologically recognized as Middle Woodland is linked to a period of interaction intensification with Havana-Hopewell and understood as representing a northern expression of Havana-Hopewell, entrenched within Havana-Hopewell economic and political realms (Bennett 1952; Griffin 1967; Goldstein 1992; Mason 1981; Salzer n.d., 1965; Struever 1964; Wiersum 1968; Wood 1936).

The project connects community and community identity to culinary traditions and foodways; culinary traditions and foodways represent a form of quotidian practice that materializes the abstraction of social identity (Hastorf 2017; Hastorf and Weismantel 2007; Graff 2018). Culinary traditions and foodways are gleaned from the archaeological record through examination of ingredients and processing/cooking/serving techniques. Community identity is accessed through a study of culinary traditions and foodways that examines evidence for: (1) the continuation and/or difference (and the nature of differences) in daily practices or habitus; and (2) the emergence of indicators of a stronger sense of community identity. A robust combination of analytical methods, implementing a ceramic vessel use alteration study as well as investigations of well preserved plant macroremains and faunal remains, allows for a multi-faceted and robust interpretation of the material data. Chemical residue analyses, to identify vessel contents, and radiocarbon dating, for the development of a temporal framework, are further undertaken as part of the project.

Regional Context and Research Orientation

In southeastern Wisconsin, the earliest portion of the Woodland stage (Stoltman 1979) is marked by the presence of thick ware pottery dated to circa 860 to 460 BC (Benchley et al. 1997; Boszhardt 1977; Kehoe 1975). The later Early Woodland stage, denoted by the appearance of thinner walled incised-over-cordmarked (IOCM) pots, dates to early in the first century AD (Benchley et al. 1997; Salkin 1986; Stoltman 1986). The later dates on IOCM pottery suggests that these vessels may co-occur with Middle Woodland forms (Benchley et al. 1997:109). As such, the Early Woodland in southeast Wisconsin is conventionally dated from circa 500 BC to AD 100 and Middle Woodland from AD 100 to 400 (Stevenson et al. 1997), however, the real extent and association of these cultural/temporal units is unclear. The existing radiocarbon record of southeastern Wisconsin, characterized by few dates, reflects a temporal overlap of Early and Middle Woodland components. Such overlap is similar to southwestern Wisconsin Early and Middle Woodland stages, where Early Woodland Prairie ware vessels were recovered from the same contexts as Middle Woodland Havana wares (Stoltman 1990, 2005, 2006), hinting at underlying social complexities not fully elucidated by current taxonomic classifications.

The distinction between the Early and Middle Woodland stages is conventionally recognized by a shift from thick walled ceramics bearing IOCM exteriors, accompanied by contracted stemmed hafted bifaces, to cooking pots decorated with dentate stamping and associated with corner-notched and expanding stemmed hafted bfiaces. Moreover, the Early to Middle Woodland stages is marked by technological innovations, including the initial appearance and continued use of ceramic containers, changes in subsistence economies from foraging to mixed foraging/farming, and the development and practice of burial mound ceremonialism (Benchley et al. 1997; Stevenson et al. 1997).

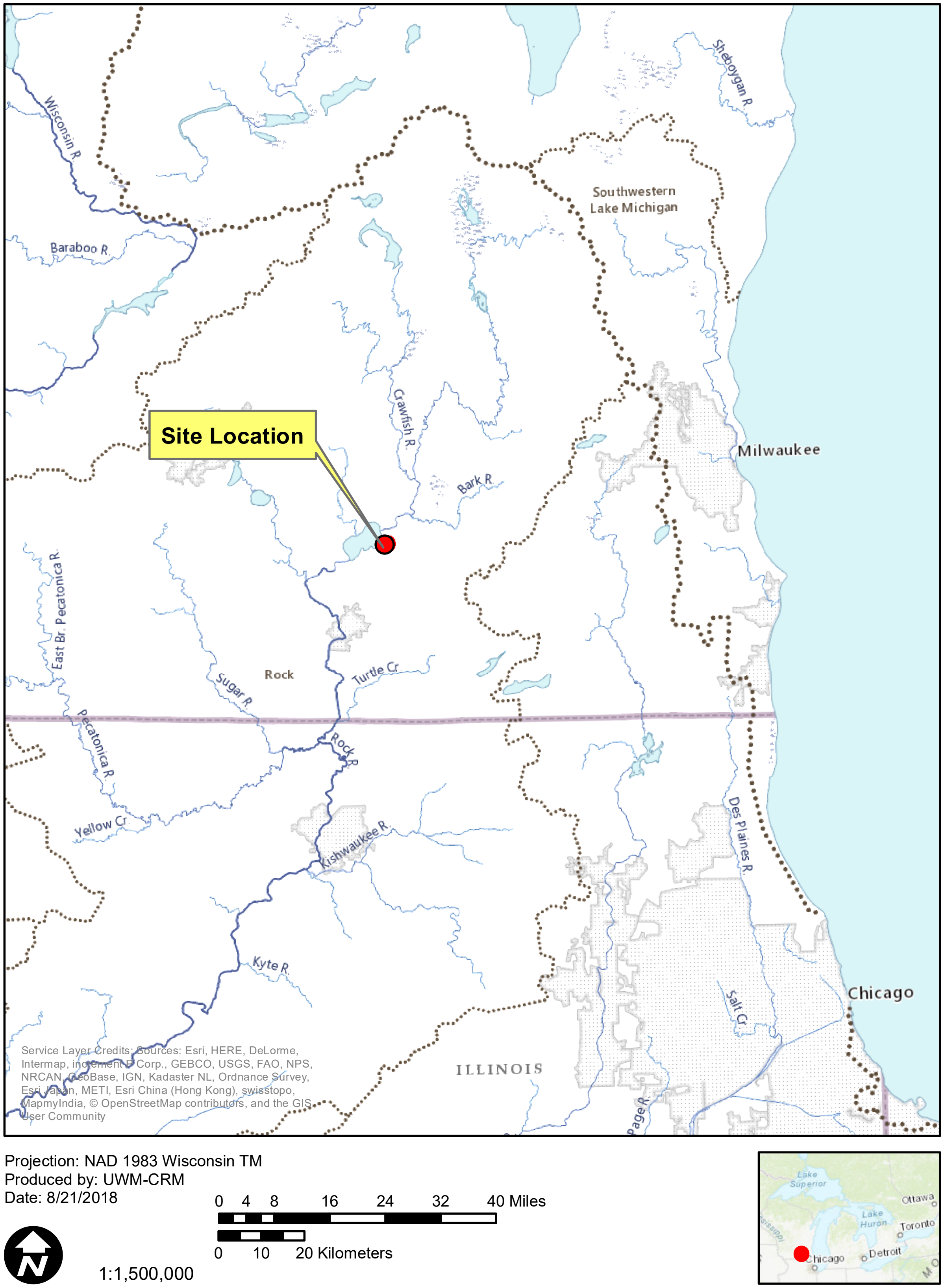


Figure 1.1. Location of the Finch site (47JE0902) in southeastern Wisconsin.

Although these broad trends are recognized, a robust understanding of Early Woodland and Middle Woodland in southeastern Wisconsin is hampered by a limited archaeological data set. Many sites in the region have been identified as containing Early and/or Middle Woodland occupations, but few sites have been subjected to large scale, systematic excavation (Benchley et al. 1997; Goldstein 1992; Jeske 2006; Jeske and Kaufman 2000; Rusch 1988). Consequently, basic chronological data is lacking, and little is known about Early and Middle Woodland lifeways, detailed subsistence regimes, settlement patterns, technological innovations, and relationships with contemporary groups. Over two decades ago, Stevenson et al. (1997:164) noted that Middle Woodland in southeastern Wisconsin remains "an enigma", an assessment that continues to be accurate today. The limited data suggest that people occupying southeastern Wisconsin during the Early Woodland and Middle Woodland were seasonally mobile foragers largely relying on a variety of wild plants and fauna, with some evidence for seed cultivation (Arzigian 1987; Goldstein 1992; Salkin 1986; Salzer 1965, n.d.; Stencil 2015; Stevenson et al. 1997; Wiersum 1968; Zalucha 1988). The relationship of southeastern Wisconsin Early and Middle Woodland to similar sites in northeastern Illinois (Geraci 2016; Henrikson 1965; Mangold 2009; Pestle 2007; Wolforth 1995) has also not been fully explored.

Conceptual frameworks for Middle Woodland populations in southeastern Wisconsin have been developed using cultural-historical approaches (McKern 1942; Salzer n.d.), economic/political models (Salzer n.d.), and distance-based interaction networks (Mason 1981).The current cultural-historical framework posits that Middle Woodland groups in southeastern Wisconsin are derived from local Early Woodland antecedents that have a long history in the region (Goldstein 1992; Jeske 2006; Salzer n.d.; Struever 1964). Middle Woodland is differentiated from Early Woodland based on the appearance of Havana-Hopewell related lithic technological forms and stylistic concepts on locally produced ceramic containers, the occurrence of non-local ceramic vessels, a marked increase of exotic stone resource use, and proliferation of burial mound mortuary ceremonialism (McKern 1942; Salzer n.d.; Struever 1964; Wood 1936). These material indicators situate the southeastern Wisconsin Middle Woodland populations within the extent of Havana-

Hopewell influence (Mason 1981; McKern 1942; Salzer n.d.; Stevenson et al. 1997; Struever 1964). This influence is envisioned as Havana-Hopewell ideational aspects, stylistic elements, mortuary behavior, and practices mapped onto the material repertoire and lifeways of an indigenous population with a deep history of regional occupation (Goldstein 1992; Jeske 2006; Salzer n.d.; Struever 1964). As noted by Struever (1964:104), southeastern Wisconsin area was marginal to the Hopewell Interaction Sphere.

Middle Woodland populations in southeastern Wisconsin have been incorporated into the Waukesha Focus (or phase), understood as a regional variant, and a northern expression, of Havana-Hopewell (Bennett 1952; Griffin 1967; Mason 1981; McKern 1942; Salzer n.d.; Struever 1964; Wood 1936). Salzer (n.d.) envisioned the Waukesha phase as a key component of the geographically expansive, and economically motivated, Hopewell Interaction Sphere (Struever 1964). Waukesha phase populations were involved in this long distance system of commodity exchange, possibly including indirect trade with neighboring groups and/or a part of a re-distributive trade system (Salzer n.d.). Using this economic model, exotic lithic materials, non-local ceramic vessels, and copper were imported into Waukesha Phase sites, although little evidence exists for exported materials (Salzer n.d.).

Jeske (2006) incorporates the Waukesha Phase populations into the political and economic realm of Havana-Hopewell, invoking a world systems derived core-periphery approach (Braun and Plog 1982; Braun 1986, 1987; Brose 1979; Jeske 2006; Seeman and Branch 2006). This model posits that the Hopewell phenomena in southeastern Wisconsin resulted from trade in luxury items and information flows from the core areas of Hopewell in the Lower Illinois River Valley, and later, the Upper Illinois River Valley (Steuben Phase). Relative to mechanisms of social integration, select elements of Havana-Hopewell mortuary ritual were incorporated into a program of long term local ritual beliefs and practices (Jeske 2006).

Mason (1981) differentiates the groups occupying the Great Lakes during the Middle Woodland period by the varying degree of influence from the Hopewell centers in Ohio and Illinois; these groups correlate with three latitudinal tiers: south, middle, and north (Mason 1981). Groups in the south tier were the most influenced by Hopewell (Havana and Scioto). Middle and north tiers reflect less influence from Hopewell connections to the south and show stronger associations with various groups to the east and west. Southern tier groups may have been more sedentary than middle and northern tier groups; middle and northern tier groups were adapted to a more mobile, hunter-gatherer lifestyle that had an emphasis on fishing (Brose and Hambacher 1999). The Waukesha Phase is included as a southern tier group, along with Trempealeau (southwestern Wisconsin), Norton (southwestern Michigan), and Squawkie Hill (western New York). The southern tier groups are interpreted by Mason (1981) as having good representation in the Hopewell Interaction Sphere (Struever 1964), with Hopewell influences relative to ceramic and lithic style, mortuary programs, and subsistence-settlement traits (Mason 1981).

The underlying assumption of the normative cultural-historical frameworks and economic-political schema implies that interaction with Havana-Hopewell populations played a key role in the transformation of local Early Woodland populations into what is archaeologically recognized as Middle Woodland. The research orientation of these approaches contextualizes Middle Woodland in southeastern Wisconsin in reference to the broader Havana-Hopewell world. Such approaches do not fully explore the particular causal and functional relationships operative in specific cultural and historical settings, are mute about the social processes occurring at the local level, masking social, cultural, and economic patterns (MacSweeney 2011; Jervis 2017; Van Oyen 2013), and risk viewing groups in southeastern Wisconsin as passive recipients/participants of external cultural influences (Braun 1991; Gould 1987; Ruby 1997).

Rather than approaching the Early to Middle Woodland transition in southeastern Wisconsin using large scale/top down models, this dissertation project implements a community archaeology approach to elucidate the social processes occurring at the local level, and then examines evidence for differences in social processes of Early and Middle Woodland populations. Comparing differences between Early and Middle Woodland populations allows for the examination of whether or not there was a radical transformation of the social realm, as evidenced through culinary traditions and foodways, associated with the Middle Woodland component and corresponding with heightened interaction with Havana-Hopewell. If such differences are identified, the community archaeology approach can examine to what extent the local social realm was affected by contemporary interactions and how external influences were locally interpreted. The lens of community archaeology allows for a robust evaluation of the impact of Havana-Hopewell interaction on the populations occupying southeastern Wisconsin.

Research Questions, Data Set, and Project Approach

The primary research question asks: *Are there significant differences in community identity, as evidenced through culinary traditions and foodways, between Early and Middle Woodland groups in southeastern Wisconsin*? If so, what is the nature of these differences and the relationship to the period of increased interaction with Havana-Hopewell? The first hypothesis evaluates evidence for differences in culinary traditions and foodways of Early Woodland and Middle Woodland populations. The second hypothesis assesses whether indicators of community identity strengthened following increased interaction with Havana-Hopewell.

A robust combination of analytic methods, implementing a ceramic vessel use alteration study as well as studies of well preserved plant macroremains and faunal remains, allows for a multi-faceted and comprehensive interpretation of the material data. The dissertation project performs a use-wear analysis of the ceramic assemblage, conducts new quantitative analyses of extant plant macroremains and faunal data, undertakes chemical residue analyses, and establishes a temporal framework to test the hypotheses. The multiple lines of evidence are used to identify culinary traditions and foodways associated with Early and Middle Woodland populations; culinary traditions and foodways are then implemented to test for differences in community and to evaluate for indicators of community identity. By using the broad expanse of time afforded by the archaeological record of the Finch site, it is possible to delineate the complex set of social and geographical dynamics involved in community identity formation, persistence, and change. The identification of these factors can further inform about how cultural traits and social practices are actively used by individuals, groups, and communities in response to changing social and historic contexts (MacSweeney 2011).

Organization of the Dissertation

This dissertation is organized into eight chapters, with the first chapters presenting a theoretical framework and overall research design (Chapter 2), regional archaeological context (Chapter 3), and an overview of the Finch site (47JE0902) (Chapter 4). The theoretical framework in Chapter 2 provides a discussion of community and community identity, and how such concepts are directly connected to culinary traditions and foodways. How culinary traditions and foodways are connected to archaeological material correlates, including cookpots, plant macroremains, and animals remains, are further discussed. Chapter 3 presents the cultural contexts for southeastern Wisconsin, focusing on the current cultural-historical paradigms and includes a review of the extant archaeological literature concerning Early and Middle Woodland sites in southeastern Wisconsin. An overview of the Finch site excavations, summarizing the Early and Middle Woodland components, is provided in Chapter 4.

Data analysis is then presented for each material type, focusing on the ceramic analysis and then consideration of the plant macroremains and faunal remains in Chapter 5 and 6. Hypothesis testing, through consideration of each research question, follows the data analysis so that all lines of evidence are considered together. Chapter 5 presents the ceramic attribute analysis and use alteration study. The results of the chemical residue analysis are included in Chapter 5 as part of the use-alteration study. Chapter 6 provides the analysis of the plant macroremains and zooarchaeological assemblage associated with the Early and Middle Woodland component.

The data analysis, integrating the results presented in Chapters 5 and 6, is provided in Chapter 7. Each research question is considered in turn and then used to test each hypothesis. Chapter 7 also provides the conclusions of the projects and presents avenues of future research Appendices follow Chapter 7.

CHAPTER 2: THEORETICAL FRAMEWORK, HYPOTHESES, AND RESEARCH METHODS

Introduction

This chapter presents the theoretical framework, hypotheses, and an overview of the research methods for the dissertation research. The theoretical framework, based in practice and structuration theory, establishes and defines the concept of community and community identity, concepts that are key to this dissertation project. The correlation between community and culinary traditions and foodways is elucidated, providing the link between archaeological material remains and the theoretical framework of communities. The primary hypothesis and the more detailed research questions are then presented. The chapter concludes with an overview of the research methods employed to test the hypotheses.

Community, Community Identity, and Culinary Traditions and Foodways

Grounded in practice theory (Bourdieu 1977) and structuration theory (Giddens 1984), the archaeology of communities provides the theoretical framework that models the nature of social life, social change, and social processes (Carr and Case 2006; Ortner 1984) (Figure 2.1). The research seeks to identify those processes by which social phenomena are actively generated, a framework that posits questions of how rather than why, underscoring the importance of local historical contexts (Dobres and Robb 2000; Ortner 1984).

The application of practice theory in archaeology is based on Bourdieu's (1977) concepts of habitus, people's dispositions, and doxa, those second nature ways of doing or knowing that become orthodoxies and heterodoxies (Bourdieu 1977; Dietler and Herbich 1998; Dobres and Robb 2000; Ortner 1984; Pauketat 2001). The dispositions that guide practice have doxic referents, the unconscious, spontaneous, nondiscursive, practical, commonsense forms for knowledge. The day to day activities of life are ordered according to socially perceived norms and these activities are recreated each day (Bourdieu 1990; Palmer and Van der Veen 2002). All people enact, embody, or represent traditions in ways that continuously alter those traditions.

Practice, defined as the actions and representations of individuals, are generative and represent the process as well as the consequences of processes. Practices are constrained in some ways by meaning, ideologies, identities, traditions, and various other macro-scale phenomena (Shennan 1993). The idea of practice focuses attention on the creative moments in time and space that generated change, processes located in micro-scale actions and representations. Micro-scale process may exist simultaneously as macro-scale processes such as domination, transculturation, communalization, creolization, and ethnogenesis (Pauketat 2001). Practices are historic processes as they are shaped by what came before them and they give shape to what follows. The archaeological study of the process of history examines how change occurred and how meanings or traditions were constructed and transmitted. History is viewed as shaped by how all people embodied their traditions, how they acted and represented themselves (Bradley 1996; Pauketat 2001).

A practice approach is closely connected with Gidden's (1984) concept of structuration theory. Structuration posits that people understand the social rules that shape their lives and manipulate these rules, either reinforcing or altering the existing social structure (Twiss 2007). Thus, structuration underscores the intentions or agency of individuals or social groups.

Community and Community Identity

Communities have been defined in multiple ways, ranging from the conceptualization as a natural and universal form of human organization arising from residential proximity, to the notion of imagined communities (Anderson 2006; Harris 2014; Isbell 2000; Kolb and Snead 1997; MacSweeney 2011). The community approach to archaeology adopted for this project views society as actively produced by human beings through their interactions, recognizing that humans are social products and that social forms are an objective reality (Berger and Luckmann 1967; Harris 2014; Ortner 1984; Yaeger 2000).

Community is the conjunction of people, place, and premise, an ever-emergent social institution that generates and is generated by supra-household interactions that are structured and synchronized by a set of places within a particular period of time (Yaeger and Canuto 2000). Community structures the practices of its members within defined spaces and is also the continual product of that interaction, thus having a definite and irreducible historical quality (MacSweeney 2011; Yaeger and Canuto 2000). The abstraction of community identity becomes manifest through active engagement between people and things, allowing material remains of past actions to reflect group values and style preferences in production and consumption (Dietler 2007; Hastorf 2017; Pauketat 2001).

The community is a socially constructed form of collective identity, rooted in the experience of residential proximity and shared space, built on and around a perception of commonality between members and nonmembers, and situated in its own unique historic context (Cohen 1985; Yaeger and Canuto 2000; MacSweeney 2011; Yaeger 2000). A perception of commonality is maintained through social practice, or habitus (Bourdieu 1977; MacSweeney 2011). Identity refers to the affiliation of an individual or a group with a selected broader group and not other groups, a dynamic and situationally specific phenomenon that shapes and is shaped by cultural practices and experiences (Twiss 2007).

The *concept* of community, as used herein, necessarily involves a physical space and place, venues for the repeated, meaningful interactions that are necessary for the creation and maintenance of community (Yaeger and Canuto 2000). Shared place and the shared experience of residential proximity provides a medium through which a sense of cohesion and shared identity can develop based on the commonality of experience (MacSweeney 2011). The daily routines, the choreography of living and texturing of place, creates emotional bonds that sustain a sense of community (Whittle

2005). Locality ensures that co-residents will have some shared phenomenological experience as well as common elements of social habitus that allow for the formation of a sense of community identity. This sense of collective identity does not occur automatically (a "natural state") from simple geographical proximity (Murdock 1949); however, it can potentially crystallize through the embodied experience of co-residence and shared social practices (MacSweeney 2011:20; Yaeger and Canuto 2000). As such, residential proximity does not explain how and why a conscious sense of community may be constructed but instead creates the environmental conditions where such an identity becomes salient.

The community is also defined relationally, a mental construct where members of the community feel a sense of cohesion and shared identity based on some perception of commonality (MacSweeney 2011). This sense of community is rooted in social experience and social practice and it is through these shared experiences and practices that identity is continually created and re-created, changed, and transformed (Canuto and Yaeger 2000). Thus community is purposely and inextricably tied to the concept of community identity so that community and community identity are considered one and the same.

Community identity is the concurrent development and representation of a sense of "us" and a sense of "other" (MacSweeney 2011; Yaeger 2000). The sense of "us" is deliberately constructed from social practice, enactments of community (MacSweeney 2011), practices of affiliation (Yaeger 2000), affiliation dramas (Strathern and Stewart 2000), the active construction of promoting a sense of unity and togetherness, highlighting commonalities and glossing over internal divisions. The practices act to produce and are simultaneously the products of a conscious ideology of a community togetherness (Canuto and Yaeger 2000; MacSweeney 2011).

Group identities, as flexible social constructs, only become salient in specific historic situations for a specific set of social reasons. The social dynamics within a settlement may have encouraged a conscious sense of community identity at particular times and in particular historical circumstances, there may equally have been times when the concept of community was not so important

(MacSweeney 2011). Individuals and groups resident in the settlement may have struggled to shape the community identity in different and contradictory ways. The points at which community identity become salient and the moments at which it ceases to be are of crucial importance, asking when and why does the identity of a community as a group rise above the various forms of individual identity that intersect it.

The definition of community used for this project, as outlined above, references a social institution of shared ideals that is *created* and *enacted* through regular face to face interaction and the *intentionality* of individuals and social groups (*sensu* MacSweeney 2011; Sterner 2018). Individuals participate in community as a social act and, by doing so, signal an acceptance of a common social world order or doxa. Community identity is viewed as a form of social integration that actively creates a sense of "us" and sense of "other" (MacSweeney 2011). The material assemblages archaeologically classified as Early and Middle Woodland are thus conceptually viewed as potentially representative of distinctive communities.

Culinary Traditions and Foodways

Over the past thirty years, topics of diet and subsistence have been an important foci in archaeological research (Graff 2018). Such studies commonly contextualize past foodways as part of a subsistence regime and/or domestic economy. More recently, a new approach has been developed that embeds foodways within a broader conceptual framework of cooking and food preparation practices (Graff 2018; Graff and Rodriguez-Alegria 2012; VanDerwarker et al. 2016). The study of cooking and food preparation practices, for this project referenced as *culinary traditions and foodways*, has demonstrated great potential to reveal social information. The study of cooking and food preparation identifies ways in which everyday practice changes and/or continues in the political, economic, religious, and sociocultural realms (Graff 2018). Moreover, cooking and food processing is an aspect of social and cultural identity and a fundamental part of social life (Atalay and Hastorf 2006; Graff 2018; Villing and Spataro).

The theoretical undergirding of culinary traditions and foodways is practice and structuration theory (Bourdieu 1977; Giddens 1984). These theories model how social information is embedded in culinary traditions and foodways as well as provide the link with community and community identity (Figure 2.1).

The practice theory approach focuses on how people were cooking, the choices that they made, and how the actions involved in processing foods were part of a daily routine or something that occurred (or did not occur) on a regular basis (Graff 2018). Eating is a social act, repeated nearly every day for biological survival, occupying a salient place among the various routinized practices that, as Bourdieu (1990) has explored at length, serves to inculcate habitus, the set of embodied dispositions that structure action in the world and that unconsciously instantiate perceptions of identity and difference (Dietler 2007; Yaeger 2000). The repeated food preparation gestures and actions with specific tools, and the sequences in which they occurred, both make and reproduce cultural identities and social distinctions that are archaeologically recognizable (Hastorf 2017; Gifford-Gonzalez 2008; Graff 2018; Twiss 2007; Villing and Spataro 2015). As such, the daily interactions that surround cooking and serving meals are important contexts for the production and materialization of a people's worldview (Hastorf 2017). The daily, shared habitus of food traditions creates an impression of unity within and commitment to a larger community, affirming community through its web of symbolic meanings, and the embodied memories of repetition and form (Hastorf 2017:225).

Structuration theory, as applied to culinary traditions and foodways, focuses on the intentional actions (or agency) of the social groups that are selecting foods and preparing them in a particular manner (Graff 2018). Transforming materials into culturally acceptable foods is an active process that involves individuals, their knowledge, and a variety of other factors acknowledged by individuals (Graff 2018). Selection, preparation, and consumption of food serve to constitute and distinguish individuals as members of a cultural group (Gifford-Gonzalez and Sunseri 2007). In this manner, foodways are condensed social facts reflecting the dispositions and values of a group, active in all practices of identity formation (Hastorf 2017; Sahlins 1976, Stahl 2002; Sutton 2001). As learned, culturally patterned techniques of bodily comportment, foodways are expressive in a fundamental way of identity and difference (Dietler 2007; Egan-Bruhy 2014; Graff 2018; Hastorf 2017; Ohnuki-Tierney 1993; Twiss 2007). Foodways, the literal incorporation of a material symbol, represent a powerful representation of identity (Twiss 2007). Food choices are related to how people perceive their environment and project themselves within it, and how people view themselves within a cultural and social group and interact with their social milieu (Chevalier et al. 2014). Foodways materialize the abstractions of identity, political standing, authority, belief systems, and social history through remembrance and reenactment of past meals with each newly created meal (Hastorf 2017; Roddick and Hastorf 2010).

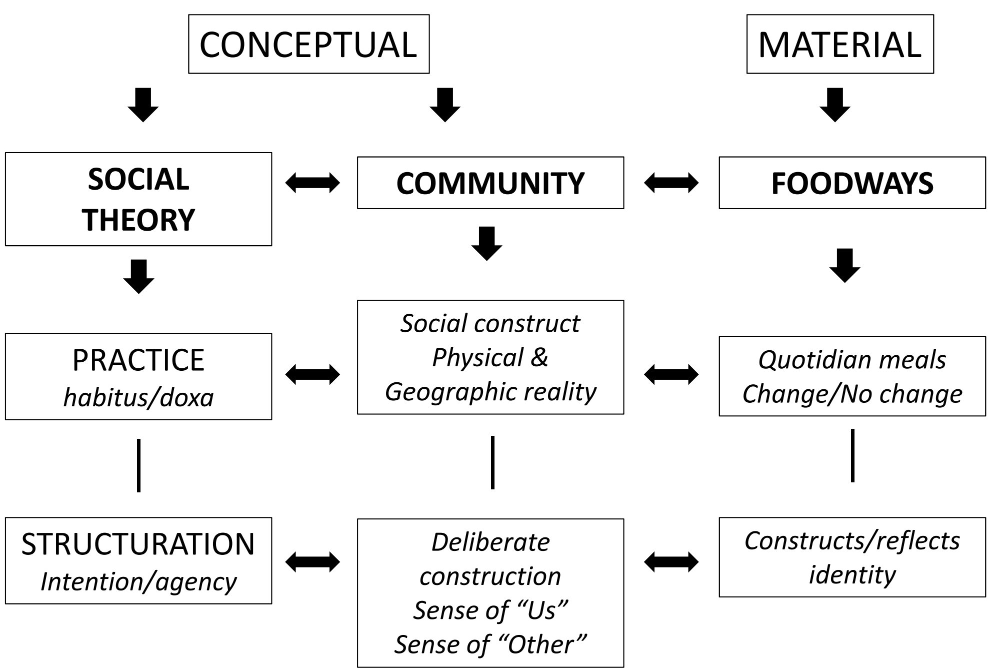


Figure 2.1. Theoretical model delineating connections between social theory, community, and foodways.

Across cultures, food preparation and consumption play an important role in integrating society and is often a central part of ritual and social gatherings (Babcock 1990; Hastorf 2017; Hegmon 1989; Mobley-Tanaka 1997; Palmer and Van der Veen 2002). Food practices are one of the ways that social relations and divisions are symbolized, reinforced, and reproduced on a daily basis (Charles and McKern 1988; Hastorf 2017; Mobley-Tanaka 1997). Membership in a group is defined by food choices that are commonly agreed on, thus social boundaries are established through foodways (Hastorf 2017; Jansen 2001). Moreover, retaining membership in a group requires active participation including consuming what the community deems acceptable (Douglas 1966; Hastorf 2017). The explicit rules that define a community are based on long held social mores, defining status, morals, values, and proper comportment. These rules channel practices, which in turn create social boundaries around people (Hastorf 2017; Douglas 1966).

Community Identity in Culinary Traditions and Foodways

For this research project, community and community identity are expected to be materially manifested in culinary traditions and foodways. Culinary traditions and foodways represent a material representation of community and community identity (Figure 2.1). The daily meal, as a quotidian practice and representation of habitus, reflects social aspects of a group. Changes, or lack there of, can therefore speak to concordant changes or differences in sociocultural realms (Hastorf 2017; Graff 2018). The anthropological and archaeological literature is replete with examples connecting foodways to social and community identity (Fortier 2006; Gifford-Gonzalez and Sunseri 2007; Hastorf 2017; Ohnuki-Tiery 1993; Roddick and Hastorf 2010; Scott 2007; Twiss 2007). Beliefs about the proper way of being in the world, especially about preparing and eating food, reflect how communities represent themselves; transformations that do or do not occur when communities interact with others illustrates both their cultural resilience and their power to engage in this cultural contact (Hastorf 2017:245). Cuisine transformations are usually correlated with social or political upheaval (Hastorf 2017). Traditional foods presented using unfamiliar etiquette and new ingredients in common dishes are some of the way foodways may change relative to shifting group identities (Hastorf 2017). Changes in plants, animals, and vessels often occur before other material signs of contact appear in the archaeological record, underscoring the importance of foodways to studying meaning in past social and political worlds (Hastorf 2017). In short, culinary traditions and foodways also materialize the abstraction of identity (Hastorf 2017).

Community identity can be accessed through a study of culinary traditions and foodways that examines evidence for: (1) the continuation and/or differences (and the nature of the differences) in habitus; (2) the presence of indicators of community identity; and (3) significant changes or transformation of community identity.

Continuation and Differences of Habitus

At the heart of local community is a set a shared understanding, created and recreated in daily pursuits and interactions, a local habitus (Watanbe 1992; Yaeger 2000). Fundamental concerns of production and consumption are salient indicators of a local practices indicative of habitus (Yaeger 2000). The study of foodways is a way to get closer to quotidian and redundant daily practices, the everyday events that keep the family, the kin group, and the community together, reflecting and shaping the social and political world of participants (Graff 2018; Hastorf and Weismantel 2007). The domestic meal creates shared traditions and is at the core of past social lives (Hastorf and Weismantel 2007). Local habitus is indicated by taxonomic representation of plant and animal taxa as well as the manner in which these materials were processed, prepared and served (Gifford-Gonzalez and Sunseri 2007).

Indicators of Community Identity

Processes that serve to ameliorate social difference and individual status are archaeological indicators of community identity formation, recognized by the homogenization in type and form of material objects (MacSweeney 2011). This increased consistency in the ways of doing everyday things (Hegmon 1992) is manifest in the standardization (decreased variability) of technical/

decorative choices and artifact form, actively creating a stronger sense of "us" (MacSweeney 2011). Relative to culinary traditions and foodways, increased homogenization may manifest as decreased variability in cooking/processing/serving/storage techniques. The association of certain foods (represented by plant and/or animal taxa) may be prepared and served in a consistent manner. The preparation and serving of these foods may occur in certain containers that exhibit particular design elements so that, overall, there is decreased variability between the association of plants, animals, cooking facility form, and container form.

Evidence of feasting evidences a more robust "sense of us", reflecting a type of "enactments of community" or "practices of affiliation" (MacSweeney 2011; Yaeger 2000). Characteristics of feasts include abundance of particular plant or animal taxa and use of atypical ingredients (Hastorf and Weismantel 2007). The use of specific ingredients may be indicated by their rarity within refuse pits or depositional histories (Hastorf and Weismantel 2007). The juxtaposition of butchery, refuse disposal, and contextual evidence can also distinguish patterns typical of quotidian household meals versus communal ritual feasts (Clifford-Gonzalez and Sunseri 2007; McKuscick 1981; Potter 1997).

Finally, the development of the sense of "us" is linked to the concurrent development of the sense of "other" (MacSweeney 2011). Material correlates involving the formation of a sense of the "other" are those objects and visual styles that are likely to have carried connotations of certain external groups, acting as symbols that represent the people, place, or ideology they recall (MacSweeney 2011:49; Appadurai 1988:38; Knappett 2005:119). The importance of social meaning occurs at the point of consumption, the meaning that an object has may be radically different from those attached to it at the time of its production or at other stages in its life history. Objects can accrue new meanings, forged in the active process of cultural encounter and hybridization (MacSweeney 2011:52). Appropriation and use of exotic materials, and the manner in which these items were consumed and contextual activities, relative to culinary traditions and foodways, informs on the development of a sense of other key to the formation of a community identity.

Transformation of Community Identity

Culinary traditions and foodways can inform about how societies or social groups define themselves and how others might define those groups in turn (Dawdy 2010; Graff 2018; Twiss 2012). Distinctive community identities may be marked not only by significant differences in culinary traditions and foodways, but also the character of the differences. Major differences in ingredients, processing, storing/serving indicating a radical departure from the long history of the ways of doing everyday things may reflect a shift in community identity.

Archaeological studies that examine food preparation identify multiple examples of nuanced relationships between regions, sometimes including the active construction of new, interregional communities (Graff 2018; Stein 2012; Sunseri 2015). Further, pertinent to southeastern Wisconsin, from 100 BC to AD 400, is evidence for the adoption of Havana-Hopewellian elements that would indicate that the community identity was not only transformed, but specifically appropriated elements of Hopewell. Such appropriation of Hopewellian elements may indicate that southeastern Wisconsin groups became part of a broader Hopewellian relational, or symbolic, community (Ruby et al. 2006).

Recent Hopewell research has demonstrated the ritual/ceremonial/symbolic significance of certain ceramic types and plant taxa (Braun 1986; Braun and Plog 1982; Seeman 1995; Wymer 2009). Socially integrative (ceremonial) activities occurring within the domestic sphere have been recognized for Hopewell (Carr 2006; Keller and Carr 2006). Havana-Hopewell diets included indigenous cultigens (chenopod, erect knotweed, little barley, and maygrass), oily seed plants (sunflower, sumpweed), squash, tobacco, with limited evidence for maize (Simon and Parker 2006; Simon 2017). Hunting of white-tailed deer and gathering of wild resources (nuts and local seeds) remained important subsistence pursuits. Havana-Hopewell sites typically yield high quantities of hazelnuts, suggesting that this resource was an integral part of the Middle Woodland lifeways (Simon and Parker 2006). Peripheral groups to the core areas of Hopewell experienced significant changes in the procurement and production of starchy seed plants and an overall increase in plant diversity suggesting the transformation of foodways linked to community identity (Fortier 2006).

Other elements of culinary traditions and foodways that may be expressive of Havana-Hopewellian worldview involve incorporation of specific design elements and motifs on cooking/serving/storing ceramic containers. Ceramics are necessarily connected to the role of food preparation and consumption as the overwhelming primary function of vessels is the processing, storing and transporting of food and liquids (Rice 1987; Skibo 2013). Ceramics used in socially integrative activities differ in some way from those used in other contexts (Hegmon 1989). Ethnographic and archaeological examples support the general association of distinctive ceramics with special contexts (Braithwaite 1982; Deetz 1972; Hegmon 1989; Prufer 1965). Finely executed motifs, using hemiconical punctates, narrow incised lines, rocker stamps, small nodes and brushing, in repetitive design patterns, often occurring in opposition are recognized as uniquely Hopewellian characteristics that may represent a form of a regionally based symbolic communication system (Fortier 2006; Seeman 1995). Not only are the presence of the design elements important, but the context of their occurrence relative to ingredients, processing, and serving/storage techniques reflects significance. It is this context that is key to identifying and understanding the local appropriation of Hopewellian elements and connection to community identity.

Predicted Outcomes and Expectations

Based on the current understanding of Havana-Hopewell, as well as the current cultural-historical frameworks for southeastern Wisconsin, there is the expectation for the transformation of community identity, *as expressed through culinary traditions and foodways*, of groups occupying southeastern Wisconsin during the Early and Middle Woodland periods. There are three factors that can be referenced as to why we might suspect differences in community and community identity of Early and Middle Woodland groups in southeastern Wisconsin: (1) there are archaeological material culture differences between Early and Middle Woodland suggesting stylistic and technological differences; (2) current conceptual frameworks contextualize southeastern Wisconsin Middle Woodland within the political, economic, and social realm of Havana and Havana Hopewell

(Jeske 2006; Mason 1981; Salzer n.d.; Struever 1964); and (3) the Hopewellian phenomena itself has been conceptualized as a mechanism of community formation occurring at the local, regional, and extra-regional levels (Ruby et al. 2006).

As the first two factors were described in Chapter 1, the following discussion focuses on the Hopewellian phenomena relative to community and community identity. Havana-Hopewell and Hopewell has been conceptualized as an ideational phenomenon, transformative in the sense that new forms of relational communities emerge between local, regional, and extra-regional groups (Ruby et al. 2006). The Hopewell phenomenon has been modeled as a process of community identity transformation through the development of relational communities that may or may not be circumscribed by geographical space (Carr 2006; Ruby et al. 2006). This concept characterizes Hopewell as the concurrent representation of a locally interpreted, regionally varied phenomenon grounded in each region's unique historical context, and a supra-local phenomenon derived from practices/forms/symbols that are consistent across regions. The local/supra-local nature of Hopewell is also conceptualized as local, residential, and symbolic communities (Ruby et al. 2006).

The concept of local/residential, sustainable, and symbolic communities defines a process of group identity formation wherein individuals actively construct and negotiate group identity and affiliation (Ruby et al. 2006; Chivis 2016). Local communities are the spatially distinct clusters of residences with regular daily interaction whose members share a common identity and co-residence or close residence (Carr 2006; Chivis 2016; Ruby et al. 2006; Varien 1999). Sustainable communities network on a larger scale representing the spatial and demographic components necessary to maintain residential communities. Symbolic communities integrated residential communities into larger, more inclusive groups and were expressed in the cultural practice of monumentalism, reflective of a ceremonial context broader than solely funerary ritual (Buikstra et al. 1998; Charles et al. 2004; King et al. 2011).

The Hopewell phenomena as reflective of community identity transformation, including the appearance of forms of a supra-local relational community (or symbolic communities), has been documented amongst peripheral Hopewellian groups in western Michigan and the American Bottom (Chivis 2016; Fortier 2006). In the American Bottom, the shift to Havana-Hopewell was dramatic, including changes in settlement type, ceramic style and technology, stone tool technology, and foodways (Fortier 2006). Based on this evidence, characterized as a technological and horticultural revolution, Fortier (2006) argues that the American Bottom communities were leading towards the development of their own identity (Fortier 2006). In western Michigan, interaction with Havana-Hopewell groups led to the formation of local and regional communities, new social/cultural identities distinct from local Early Woodland populations (Chivis 2016). Residential communities were geographically circumscribed to specific river valleys, connected to each other as a sustainable community, and formed a relational identity, a symbolic community, expressed in the local interpretation and adoption of Havana and Hopewell designs (Chivis 2016).

Hypotheses

This project explores the correlation between culinary traditions and foodways, the concept of community, and the formation of community identity of Early and Middle Woodland groups in southeastern Wisconsin. The relationship of culinary traditions and foodways vis à vis heightened interaction with Havana-Hopewell is further investigated by the project. The primary thesis poses the question:

Are there significant differences in community identity, as evidenced through culinary traditions and foodways, between Early and Middle Woodland groups in southeastern Wisconsin? If so, what is the nature of this difference and the relationship to interaction with Havana-Hopewell?

Community identity is accessed through a study of culinary traditions and foodways, examining evidence for: (1) similarity and/or difference (and the nature of differences) in daily practices or habitus; and (2) the presence of indicators of a stronger sense of community identity manifest in Middle Woodland groups relative to Early Woodland populations. Two hypotheses are generated from the primary thesis (Figure 2.2). The first hypothesis evaluates evidence for differences in culinary traditions and foodways between Early and Middle Woodland populations. The second hypothesis assesses whether a stronger sense of community identity is associated with Middle Woodland populations, correlating with more intensive interaction with Havana-Hopewell. To test the hypotheses, a series of five specific research questions are developed that are addressed using multiple lines of material evidence consisting of plant macroremains, faunal remains, and ceramics from the Finch site (Figure 2.2). The use of multiple sources of material data to identify culinary traditions and foodways is of critical importance as reliance on only one may lead to incorrect inferences (Graf 2018; Olsson and Isaksson 2008; VanDerwarker et al. 2016).

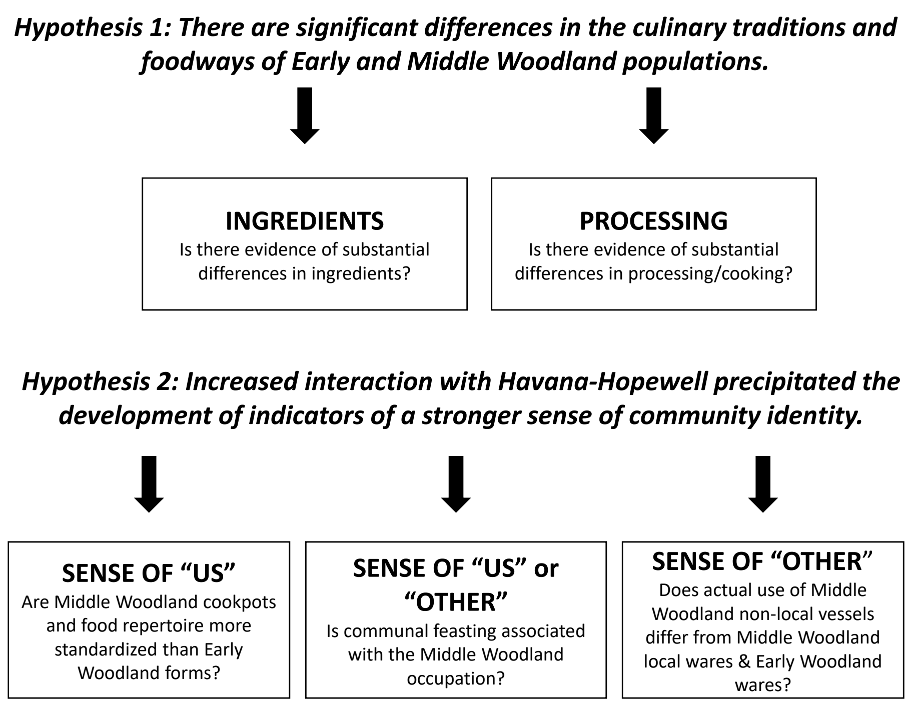


Figure 2.2. Hypotheses and research questions.

Hypothesis 1: There are significant differences in the culinary traditions and foodways of the Early Woodland and Middle Woodland populations.

At the heart of local community is a set of shared understanding, created and recreated in daily pursuits and interactions, a local habitus (Watanbe 1992; Yaeger 2000). Fundamental concerns of production and consumption are salient indicators of local practices indicative of habitus (Yaeger 2000). The study of culinary traditions and foodways is a way to get closer to quotidian and redundant daily practices, the everyday events that keep family, kin group, and community together, reflecting and shaping the social and political world of participants (Hastorf and Weismantel 2007). The domestic meal creates shared traditions and is at the core of past social lives (Hastorf and Weismantel 2007). Local habitus is indicated by taxonomic representation of plant and animal taxa as well as the manner in which these materials were processed and prepared (Gifford-Gonzalez and Sunseri 2007). Major differences in ingredients and processing techniques indicates a radical departure from the long history of the ways of doing everyday things possibly reflecting a shift in community identity.

Ingredients refer to the taxonomic representation of plant and animals used by a community. Some ingredients may be identified as signature foods, those salient in a culinary tradition that reflect identity and create community through the shared attention that they receive from community members (Hastorf 2017). Processing/cooking techniques include those actions involved in the preparation and serving of foods.

The empirical examination for evidence of differences in culinary traditions and foodways between Early and Middle Woodland populations is foundational to this dissertation research project. The null hypothesis, that culinary traditions and foodways reveal little differences, despite intensification of interaction with Havana-Hopewell groups, would alter the current conceptual frameworks for southeastern Wisconsin Early and Middle Woodland stages. Such a scenario would indicate that, although groups in southeastern Wisconsin were influenced by the Hopewell phenomena, such involvement did not result in a radical transformation of the social realm. In this manner, southeastern Wisconsin Middle Woodland may not be considered a regional variant of Havana-Hopewell, effectively marking a boundary for the extent of the Hopewellian phenomenon. Moreover, the conservatism in the social lifeways of southeastern Wisconsin, through a period of time that witnessed technological transformations, could further elucidate those mechanisms, unique to the local historical context and social processes, that resulted in such stability.

Two research questions test Hypothesis 1 using the archaeological data from the Finch site.

Research Question 1: Is there evidence of substantial differences in ingredients?

This research question is tested through a formal comparison of the Early and Middle Woodland component plant macroremain and zooarchaeological assemblages and chemical residue analysis of ceramic vessels. For each component, the plant macroremain and zooarchaeological assemblages are separately analyzed relative to overall composition, abundancy, and ubiquity. The plant macroremains and zooarchaeological assemblages are then integrated using ubiquity and diversity measures (VanDerwarker 2010).

Chemical residue analysis of a sample of the Early and Middle Woodland ceramic vessels is also undertaken to identify vessel contents associated with each component. Comparison of the Early and Middle Woodland vessel contents is accomplished qualitatively, as well as through relative frequencies of vessel residues.

Research Question 2: Is there evidence of substantial differences in processing/cooking techniques?

The evidence for differences in processing/cooking techniques is evaluated through the functional analysis of the ceramic assemblages as well as aspects of the plant macroremain and zooarchaeological assemblages.

The ceramic use wear analysis is conducted to confirm the function of the Early and Middle Woodland vessels as used primarily for cooking related tasks, as well as to assess cooking method, hearth design, and cooking mode.

Four aspects of the plant macroremain and zooarchaeological assemblages are analyzed in order to evaluate and compare processing activities associated with the Early and Middle Woodland components: (1) relative frequencies and patterning of wood charcoal; (2) presence and types of cut marked bone; (3) faunal fragmentation ratios; and (3) type and relative frequencies of burned bone. These data identify the sitewide patterning of burning that serves as a proxy for the intensity and frequency of activities involving fire and delineate the specific types of processing activities associated with each component.

Hypothesis 2: Increased interaction with Havana-Hopewell precipitated the development of indicators of a stronger sense of community identity.

Hypothesis 2 identifies key indicators of community identity evidenced within the Early and Middle Woodland occupations and then evaluates whether a stronger sense of community identity is associated with the Middle Woodland component. Material correlates of community identity are those objects and processes that are linked concurrently to a sense of "us" and a sense of the "other" (MacSweeney 2011; Yaeger 2000). This dissertation project uses three criteria to evaluate for a stronger sense of community identity: the occurrence of more standardized cookpots and foodways, evidence of communal feasting, and differential use of non-local vessels.

Processes that serve to de-emphasize social difference and individual status are archaeological indicators of community identity formation, recognized by the homogenization in type and form of material objects (MacSweeney 2011). This increased consistency in the ways of doing everyday things (Hegmon 1992) is manifest in the standardization of technical choices and artifact form, actively creating a stronger sense of "us" (MacSweeney 2011). Relative to culinary traditions and foodways, increased homogenization may manifest as decreased variability in the cookpot form and use, as well as less diversity of plant and animal taxonomic representation.

Feasting is the communal consumption of food and/or drink beyond the daily sharing of meals (Gamble 2017; VanDerwarker et al. 2016). Evidence of feasting evidences a more robust "sense of us" reflecting a type of "enactments of community" or "practices of affiliation" (MacSweeney 2011;

Yaeger 2000). Feasting may also be representative of the “other” as a form of a socially integrative practice. Socially integrative practices are argued to have been a key characteristic of the Hopewell phenomena, serving to integrate regional/extra-regional groups, and a fundamental component of Hopewell origins and interaction networks (Braun 1986; Carr 2006; Charles 1992; Jeske 2006; King et al. 2011; Ruby et al. 2006; Seeman 1995). Socially integrative (ceremonial) activities occurring within the domestic sphere, as well as the ritual/ceremonial/symbolic significance of certain ceramic types and plant taxa, have been recognized for Hopewell (Braun 1986; Braun and Plog 1982; Carr 2006; Keller and Carr 2006; Seeman 1995; Wymer 2009).

Archaeological indicators for feasting include the presence of rare or labor intensive plant or animal taxa, signs of wasting food, and/or the presence of exceptionally large quantities of food (Hastorf and Weismantel 2007; Hayden 2001; VanDerwarker and Idol 2008). Different foods or different treatment of ubiquitous foods can indicate a special meal (Graff 2018:327). The use of specific ingredients may be indicated by their rarity within refuse pits or in depositional histories (Hastorf and Weismantel 2007). The juxtaposition of butchery, refuse disposal, and contextual evidence can also distinguish patterns typical of quotidian household meals versus communal ritual feasts (Clifford-Gonzalez and Sunseri 2007; McKusick 1981; Potter 1997). Larger vessel sizes may provide further evidence of communal feasting (Johnson 2002; Tainter 1983).

The development of the sense of “us” is linked to the concurrent development of the sense of “other” (MacSweeney 2011). Material correlates involving the formation of a sense of the “other” are those objects and visual styles that are likely to have carried connotations of certain external groups, acting as symbols that represent the people, place, or ideology they recall (MacSweeney 2011:49; Appadurai 1988:38; Knappett 2005:119). The social meaning at the point of consumption may be radically different from the meaning attached to it at the time of its production or at other stages in its life history. Objects can accrue new meanings, forged in the active process of cultural encounter and hybridization (MacSweeney 2011:52). Ceramics are necessarily connected to the role of food preparation and consumption as the overwhelming primary function of vessels is the processing, storing, and transporting of food and liquids (Rice 1987; Skibo 2013). Ceramics used in socially integrative activities differ in some ways from those used in other contexts (Braithwaite 1982; Deetz 1972; Hegmon 1989; Prufer 1965). Appropriation and use of non-local ceramic wares, and the manner in which these items were consumed relative to culinary traditions and foodways, informs on the development of a sense of "other" and is a factor in the formation of a community identity. Distinctive functions of the Havana-Hopewell related wares would suggest association with extra-regionally socially integrative practices, indicating that southeastern Wisconsin groups became part of a broader Hopewellian relational, or symbolic, community (Ruby et al. 2006).

The association of Havana wares with the adoption of non-local ingredients that enter the archaeological record at the time of heightened interaction with Havana and Havana-Hopewellian populations would further support a sense of the "other" and indicate a stronger sense of community identity. Some groups on the periphery of the core areas of Hopewell experienced significant changes related to procurement and production of starchy seed plants associated with an overall increase in plant diversity following increased interaction with Havana-Hopewell (Arzigian 2000; Boyd and Surette 2010; Fortier 2006).

Three research questions test Hypothesis 2 using the plant macroremains, faunal material, and ceramics from the Finch site, evaluating indicators of a sense of "us" and a sense of the "other" using culinary traditions and foodways.

Research Question 3: Are Middle Woodland cookpots and foodways more standardized than Early Woodland forms?

The ceramic assemblage is evaluated using attribute data relating to vessel morphology, manufacture, and decoration to assess the range of variation (number of types) associated with the Early and Middle Woodland vessels. Increased standardization correlates with a decrease in the range of variation.

Assessment of the standardization of foodways is evaluated for the plant macroremains and zooarchaeological assemblage using diversity indices. Diversity is evaluated through the measuring of richness and equitability. Richness, equitability, and the Shannon-Weaver index, which combines both richness and equitability, are calculated for the plant and animal taxa represented in the Early and Middle Woodland assemblages at the Finch site.

Research Question 4: Is communal feasting associated with the Middle Woodland occupation?

The presence of feasting is explored using the ceramics as well the plant macroremains and zooarchaeological assemblage. The ceramic vessel assemblage is assessed to determine if there is an increase in vessel size between the Early and Middle Woodland components. Evidence for patterns of plant or animal taxonomic abundance and/or rare taxa are examined for the Early and Middle Woodland components. Abundance measures are based on standardized counts and/or weights for specific plant and animal taxa and are displayed using box plots. The box plots display the frequency distribution of taxa to identify positive and negative outliers. These outliers indicate proveniences harboring very high or very low quantities of the taxa and possibly identify locales of feasting activities.

Research Question 5: Does the actual use of Middle Woodland non-local vessels differ significantly from the Middle Woodland local ware and Early Woodland ware use?

The actual use of ceramic vessels typologically classified as Havana ware are compared to the locally produced Middle Woodland vessels and the Early Woodland vessels. Both the macroscopic evidence of use wear, based on sooting, oxidation, and attrition patterns, and chemical residue analysis, are used to delineate vessel contents, hearth design, cooking type, and cooking mode.

The plant macroremains and zooarchaeological assemblages, recovered from the same proveniences as the corresponding vessels are further examined as further corroborating evidence of vessel contents.

Research Methods

A robust combination of analytic methods, implementing a ceramic vessel use alteration study as well as analyses of well preserved plant macroremains and faunal remains, allows for a multi-faceted and comprehensive interpretation of the material data. The dissertation project performs a use-wear analysis of the ceramic assemblage, conducts new quantitative analyses of extant plant macroremain and faunal data, undertakes chemical residue analyses, and establishes a fine-grained temporal framework using AMS dates to test the hypotheses. The multiple lines of evidence are used to identify ingredients, delineate specific processing techniques, and evaluate for indicators of community identity.

Ceramic Assemblage

The project conducts a re-analysis of the Finch site Early and Middle Woodland vessels based on morphological attributes relating to vessel morphology, vessel manufacture, and decoration. A new analysis, implementing a performance based use wear study, is undertaken as part the dissertation project that identifies intended and actual use of individual vessels through macroscopic techniques and chemical analyses (Schiffer 2004; Schiffer and Miller 1999; Skibo 2013, 2015). Intended function, how vessels were designed to be used, is inferred from vessel attributes relating to morphology and manufacturing. Actual function is assessed through macroscopic characteristics of sooting, oxidation, and attrition, as well as chemical residue analysis.

Plant Macroremains and Zooarchaeological Assemblage

This dissertation project conducts new quantitative analyses on the plant macroremains and zooarchaeological data recovered from the Finch site. The new analyses characterize each assemblage, based on component, through abundance measures, ubiquity values, ratios, box plots, and diversity indices (Adams and Smith 2011; Cleveland 1994; Hastorf 1999; Hubbard 1976; Kintigh 1984, 1989; Marston 2014; McGill et al. 1978; Miller 1988; Pearsall 2015; VanDerwarker and Peres 2010; Popper 1988; Reitz and Wing 2008; Scarry 1986; Scarry and Steponaitis 1997;

VanDerwarker 2003; VanDerwarker et al. 2014 Wilkinson et al. 1992). A formal comparative analysis of the Early and Middle Woodland plant remains and zooarchaeolgoical assemblage is performed that examines plant and animal taxa representation based on a qualitative assessment (types of taxa present), relative frequencies, abundance and ubiquity measures, and diversity.

Food processing is assessed through three aspects of the plant macroremains and faunal assemblage evaluating: (1) intensity and frequency of activities involving fire; (2) butchery practices; and (3) evidence for roasting, bone marrow extraction, and bone grease rendering.

Interaction and Establishing Context

In addition to the methods of material culture analysis described above, evidence for inter-regional interaction and a temporal framework is established for the Early and Middle Woodland components. The evidence for increased interaction during the Middle Woodland, as compared to the previous Early Woodland period, is examined using frequencies of non-local chipped stone artifacts. The temporal framework is established through a comprehensive synthesis of published and unpublished dates in the archaeological literature and the direct dating of a small sample of vessel residues.

Summary

This chapter presented the theoretical framework, hypothesis, and an overview of the research methods for the dissertation research. The theoretical framework implements a community archaeology approach that links community to community identity and community identity to culinary traditions and foodways. Culinary traditions and foodways inform about the formation and transformation of community identity. Grounded in practice and structuration theory, a community archaeology approach views communities as a socially constructed form of collective identity, rooted in the experience of residential proximity and shared space, built around a perception of commonality between members and non-members, and situated in its own unique historic context.

Community, therefore, is a relational construct with a geographical reality, inextricably woven with community identity. Community identity is manifest materially in the culinary traditions and foodways of a group. Foodways reflect condensed social facts, repeated nearly every day for biological survival, a set of embodied dispositions that structure action in the world as well as instantiate perceptions of identity and difference. Through foodways and culinary traditions, it is possible to identity the habitus of a group, the set of shared understandings and quotidian practices that keep the community together. Foodways reflect community identity through the concurrent development of a sense of “us” and the sense of the “other”, recognized materially through homogenization of practices and feasting. Transformation of community identity is also reflected in foodways through the local appropriation of exotic materials.

The primary research question evaluates whether or not there are significant differences in community identity, as evidenced through culinary traditions and foodways, between Early and Middle Woodland groups in southeastern Wisconsin. A series of five questions address two hypotheses. The first hypothesis evaluates evidence of differences in culinary traditions and foodways of Early Woodland and Middle Woodland populations. The second hypothesis assesses whether stronger indicators of community identity are associated with Middle Woodland populations, corresponding to increased interaction with Havana-Hopewell.

A robust combination of analytic methods, implementing a ceramic vessel use alteration study as well as analyses of well preserved plant macroremains and faunal remains, allows for a multi-faceted and comprehensive interpretation of the material data. The dissertation project performs a use-wear analysis of the ceramic assemblage, conducts new quantitative analyses of extant plant macroremain and faunal data, undertakes chemical residue analyses, and establishes a fine-grained temporal framework using AMS dates to test the hypotheses.

CHAPTER 3: CULTURAL CONTEXT

Introduction

This chapter provides an overview of the archaeological research and culture-history setting of southeastern Wisconsin to provide an appropriate context for the Finch site (Figure 3.1). A summary of the archaeological research that has been conducted in southeastern Wisconsin is first presented, followed by an evaluation of the current state of the archaeological data set used to make inferences about the region's culture history. The Early Woodland and Middle Woodland culture history is then presented, discussing key sites and touching on chronology, settlement and subsistence patterns, ceramic and lithic technology, mortuary/ritual traditions, and interaction.

Archaeological Research in Southeastern Wisconsin

The Lake Koshkonong area, including the surrounding Crawfish and Rock river drainage basins, in which the Finch site is located, has attracted the interest of antiquarians and professional and avocational archaeologists since the early part of the nineteenth century. This interest is attributable, at least in part, to the presence of numerous mound groups as well as high profile sites, especially the Mississippian village at Aztalan (47JE0001). One of the earliest descriptions of the archaeological resources of the Crawfish-Rock region was an 1837 newspaper article by Nathaniel Hyer that appeared in the Milwaukee Advertiser, noteworthy for providing an early description and sketch map of Aztalan. The archaeological resources of the Crawfish-Rock region receive considerable attention in Increase A. Lapham's *Antiquities of Wisconsin*, published in 1855. One chapter of the book is devoted solely to the earthworks and mounds of the Crawfish and Rock river basins. Lapham's careful descriptions and detailed maps provide invaluable information regarding the archaeological resource base of the Crawfish and Rock river basins before the region was impacted by European settlement and agricultural practices. Other early accounts of the archaeological resources of the Crawfish and Rock river drainages are found in the writings of Peet (1890) and Stout and Skavlem (1908). During his long tenure as the editor and publisher of the American

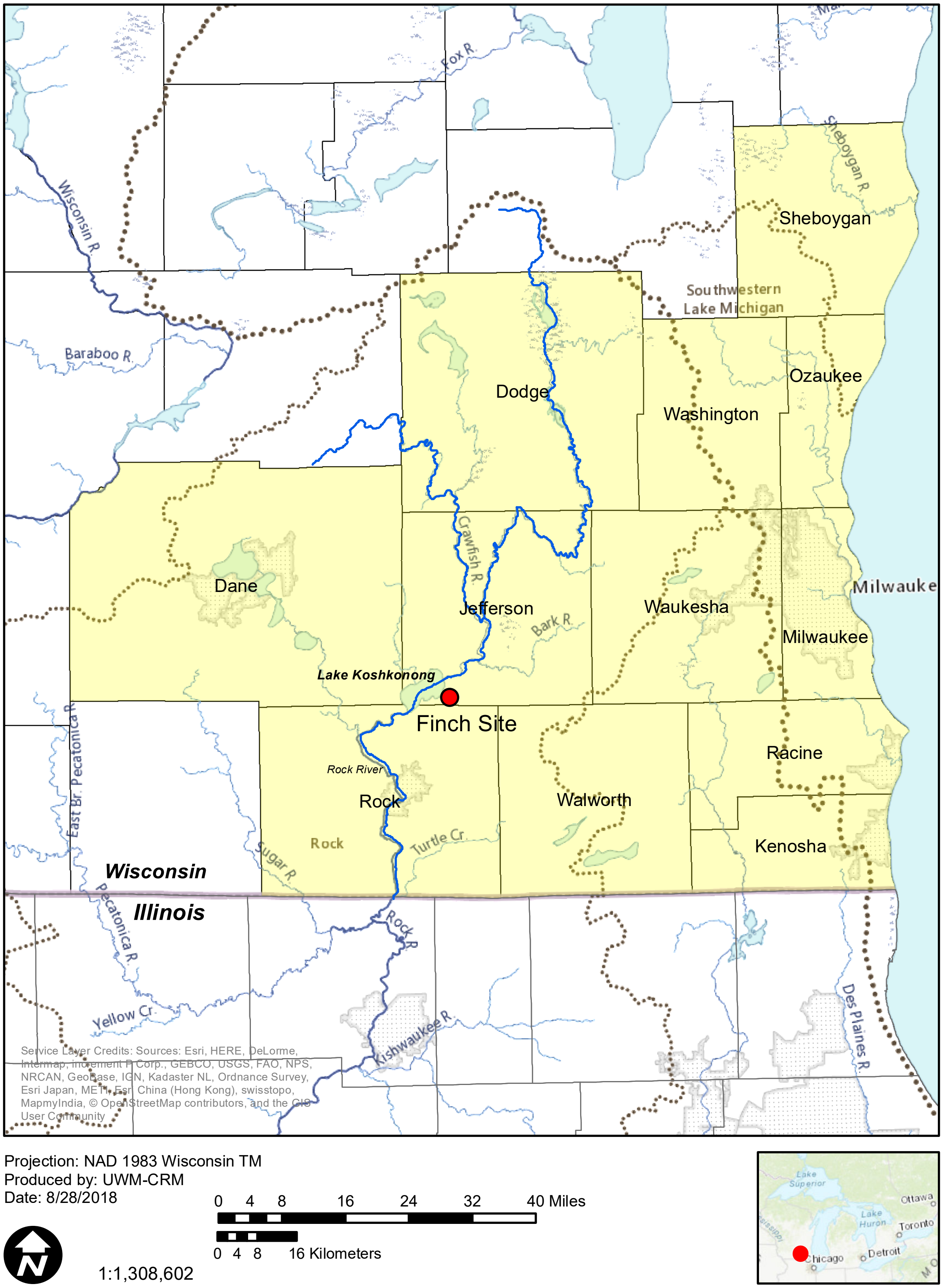


Figure 3.1. Location of Finch site (47JE0902) in Jefferson County and surrounding counties.

Antiquarian, Stephen D. Peet authored numerous articles on the mounds and antiquities of North America. In *Prehistoric America, Volume 3*, Peet (1890) provides descriptions of Aztalan as well as several mound groups located on Lake Koshkonong (Peet 1890).

Throughout the early part of the twentieth century, the archaeological resources of the Crawfish and Rock river drainages continued to attract the interest of both avocational and professional archaeologists. Much of the interest in the prehistory of the region was fostered by Charles E. Brown, director of the State Historical Society from 1908 to 1944. During his tenure at the State Historical Society, Brown communicated with individuals throughout the state who provided information about the range and variety of "antiquities" in Wisconsin. In the Crawfish and Rock river drainages, local avocational archaeologists such as Halvor Skavlem, E. H. Stiles, Robert P. Ferry, S. W. Faville, and Horace McElroy provided Brown with information regarding artifacts, site locations, mound groups, and historic period encampments. Skavlem proved to be a particularly valuable source of information for Brown. A longtime resident of the north shore of Lake Koshkonong, Skavlem developed an early interest in the natural history and archaeology of the region and freely shared his knowledge of sites throughout the Crawfish and Rock river drainages with Brown and other members of the Wisconsin Archeological Society (Mossman 1990; Skavlam 1914a, 1914b; Stout and Skavlem 1908).

In addition to corresponding with informants in the region, Brown also led one of the most extensive archaeological surveys of the Crawfish and Rock river basins (Brown and Brown 1929). Conducted between 1928 and 1934, the survey focused on a seventy mile section of the Rock River between Watertown and Beloit. The survey documented prehistoric and historic Native American village and campsites, hundreds of mounds, as well as garden beds, maple sugar processing camps, shell middens, springs, artifact caches, and rock shelters.

Beginning in the latter part of the 1950s into the 1980s, large scale archaeological surveys were conducted in advance of planned improvements to the regional transportation network. In 1963, William Hurley conducted survey for the right-of-way of the Interstate Highway 94 alignment. An archaeological survey of WIS 26 was completed between 1959 and 1961, bypasses around Fort Atkinson in 1978 (Penman 1979), and planned expansion of WIS 26 in the 1980s (Rusch 1989). The Finch site was initially identified, although as a historic Euroamerican cemetery (see Chapter 4), during the survey for WIS 26 in the late 1980s (Rusch 1989).

The late 1970s through the early 1990s witnessed several large scale surveys of the region. In 1975, a Loyola University field school under the direction of James W. Porter completed survey along the Crawfish River north of Aztalan (Stuebe 1976). The most extensive regional survey of the Crawfish and Rock river basins was that completed by the University of Wisconsin-Milwaukee's (UWM) Southeastern Wisconsin Archaeology Program (SEWAP) (Goldstein 1979, 1980b, 1981). Initiated in 1976, the SEWAP investigations consisted of surveying a stratified sample of a seventy square mile area within the Crawfish and Rock river drainage basins. In all, over 4,000 acres of land were surveyed in the region, identifying hundreds of archaeological sites (Goldstein 1987a). Many sites were later selected for site-specific investigations, including detailed mapping and test excavations. The University of Wisconsin-Milwaukee has continued archaeological research, through field schools, at Aztalan as well as the Crescent Bay Hunt Club.

The results of much of the early archaeological research in the region up to and including the SEWAP investigations, are referenced in several synthetic overviews published in *The Wisconsin Archeologist* in 1986 (Boszhardt et al. 1986) and 1997 (Stevenson et al. 1997), by the Southeastern Wisconsin Archaeology Program (Flick 1995), for east-central Wisconsin (Overstreet 1993), and within a volume in the Central and Northern Plains Archeological Overview (Benchley et al. 1997). A discussion of the Early and Middle Woodland periods of southeastern Wisconsin are provided in these overviews.

The extensive survey work within the region has identified many archaeological sites that are codified within the Wisconsin Historic Preservation Database (WHPD). For example, within Jefferson county, a total of 1,287 sites are recorded in the WHPD with 137 sites documented as having Early and/or Middle Woodland components. Although sites harboring Early and /or

Middle Woodland occupations are known for southeastern Wisconsin, a robust understanding of Early Woodland and Middle Woodland in southeastern Wisconsin is hampered by a limited archaeological data set as few sites have been subjected to large scale, systematic excavation (Goldstein 1992; Jeske 2006).

A search of sites recorded in the WHPD that have been subjected to some form of investigation beyond identification survey underscores the limitations of the archaeological data set for southeastern Wisconsin. Although there are known issues regarding WHPD data, such as the consistency and accuracy of the identified typological components, the data sets provides a coarse metric regarding the excavation of sites containing Early and Middle Woodland components in southeastern Wisconsin. As indicated in Table 3.1 and Table 3.2, approximately one percent of Early and Middle Woodland sites have been subjected to test (Phase II) excavations and a fraction of a percent of Early and Middle Woodland site have been the focus of full scale data recovery excavation projects.

Following this search, a preliminary qualitative assessment of the Early and Middle Woodland archaeological data is accomplished through a review of the source documents, as available. Nearly all of the sites identified through the WHPD data search are documented in unpublished cultural resource management reports. Moreover, many sites identified through the WHPD data search were later determined to either lack and/or have very minor Early and Middle Woodland components based on a review of the source material, and thus of little utility for the current research project. Based on this data survey, the low percentage of excavated Early and Middle Woodland sites in southeastern Wisconsin, as indicated in Table 3.1 and Table 3.2, represents an over-estimation. In all, 51 sites harboring Early Woodland components and 56 with Middle Woodland components have been subjected to some type of excavation. These sites are identified in Appendix A. This listing is not intended to be exhaustive, but rather reflects an attempt to document the Early and Middle Woodland site record of southeastern Wisconsin.

Table 3.1. Early and Middle Woodland Sites in Southeastern Wisconsin Subjected to Phase II Excavations based on WHPD Data (2018).

County	Total Number of Recorded Sites	Early Woodland Sites	Middle Woodland Sites
Dane	1592	29	34
Dodge	845	7	6
Jefferson	1291	8	13
Kenosha	465	2	4
Milwaukee	587	3	2
Ozaukee	402	3	4
Racine	351	4	6
Rock	541	4	8
Sheboygan	537	4	3
Walworth	410	5	5
Washington	457	1	1
Waukesha	691	9	4
Total	8169	79	90
Percent		0.97	1.10

Table 3.2. Early and Middle Woodland Sites in Southeastern Wisconsin Subjected to Phase III Excavations based on WHPD Data (2018).

County	Total Number of Recorded Sites	Early Woodland Sites	Middle Woodland Sites
Dane	1592	8	8
Dodge	845	1	2
Jefferson	1291	1	2
Kenosha	465	0	1
Milwaukee	587	0	0
Ozaukee	402	0	0
Racine	351	1	1
Rock	541	0	0
Sheboygan	537	1	0
Walworth	410	1	2
Washington	457	0	0
Waukesha	691	1	0
Total	8169	14	16
Percent		0.17	0.20

Early and Middle Woodland

In southeastern Wisconsin, the temporal period from circa 500 BC to AD 400 broadly encompasses the Early Woodland and Middle Woodland stages (Stevenson et al. 2007). The term "stage" correlates the terms Early Woodland and Middle Woodland with a typological class (Stoltman 1979) purposefully independent of a more specific time range. As such, Early Woodland and Middle Woodland refer to distinct taxonomic units employed to help organize and clarify the archaeological data in a scientific manner and are not necessarily representative of particular societies, cultures, tribes, and/or ethnic groups (Greber 2010; Green 1999). As with any framework, taxonomies are only useful to the extent that they increase the understanding of the data and should be altered or discarded if they fail to provide useful insights, are poorly conceived of in the first place, or if new data comes to light that introduces qualitatively different relationships (Greber 2010).

In southeastern Wisconsin, the Early and Middle Woodland stages are marked by significant technological innovations, including the appearance and continued use of ceramic containers, changes in subsistence economies from foraging to mixed foraging/farming, and the development and practice of burial mound ceremonialism. Later Early Woodland and Middle Woodland are typically differentiated based on distinct decorative treatments on ceramic vessels, projectile point/knife stylistic forms, and occurrence of non-local lithic raw materials. Early Woodland materials are characterized by grit-tempered vessels decorated with bands of horizontal or diagonal lines over a cord-marked surface, sometimes also exhibiting nodes or punctates, contracting stemmed projectile points/knives, and the use of predominantly local lithic materials. Middle Woodland material culture includes vessels with a variety of stamped motifs such as dentate, rocker, and/or cord-wrapped stick stamping, as well as punctates and nodes, expanding stemmed projectile points/knives, and a marked increase in the use of non-local lithic raw materials.

Within the Upper Midwest, the Woodland period is typically distinguished from the Archaic based on the appearance of ceramics, stemmed points, the deliberate construction of burial mounds, and the use of cultigens (Brown 1986; Emerson 1986; Mason 1981). Of these variables, one of the key indicators for the onset of the Woodland period is the appearance of pottery in the archaeological record. The innovation of ceramic technology is correlated with decreasing mobility of regional groups and intensification of plant food consumption, processing, and storage.

These classic “Woodland” characteristics have antecedents as general trends in the Archaic, so that some researchers classify Early Woodland as a Late Archaic fluorescence (Benchley et al. 1997). In the Great Lakes region, pottery technology represents an addition to an existing, and often local or in situ, hunter/gatherer economy that is slowly developing an increased commitment to a variety of food processing and storage needs (Brown 1986:603). As such, the appearance of permanent ceramic production in the region is not accompanied by a major adaptive shift (Brown 1986:605).

The trend from the Archaic to the Woodland is one of decreasing residential mobility and increased population size (Braun 1987). The decreased residential mobility, and concomitant increase of local resource use, may have been a social adaptation trade off to subsistence risk (Braun 1987:156). Areas of highly concentrated aquatic and wetland resources became increasingly attractive to people throughout the Archaic. Lacking highly storable resources and/or multiple, locally concentrated food resources (with different harvesting schedules), people could not remain in a stable residence from year to year (Braun 1987:171). As such, a more sedentary lifestyle would require means by which to counter resource shortfalls. These means may have included more reliance on cultivated plants and ceramic technology for food storage and processing. The Woodland period also witnesses an increase in burial mound construction, which also signals an increased connection to the landscape and a more sedentary lifestyle (Emerson 1986:622).

The increasing tendency towards decreased mobility, beginning in the Archaic and continuing through the Woodland, is paralleled by an intensification of plant processing, experimentation, and storage (Braun 1987). Indigenous domestication of squash, marsh elder, and chenopodium (as well as sunflower, although imported from the west), occurred between 5000 to 3500 years ago, prior to the appearance of ceramic technology (Smith 1995). The appearance of pottery in the archaeological record speaks to the importance of its initial economic and social roles (Brown 1986: 602). Pottery likely filled an utilitarian adaptive need for cultural innovation, such as nut-oil processing or more intensive seed processing (Braun 1987). Woodland pottery was designed for general purpose cooking and as food processing containers, based on their consistent overall shape, contexts of disposal, and pattern of residue (Braun 1987: 162). Thickness of the ceramic vessel reflects a balance between opposing demands as thinner walls improves thermal conductivity and resistance to failure from thermal shock, but can reduce overall durability (Braun 1987:162).

Early Woodland

In the broader Midwest and Great Lakes region, the Early Woodland period is recognized by the appearance of ceramic technology and stemmed projectile points, the deliberate construction of burial mounds, and the use of cultigens and clear evidence of plant domestication (Emerson 1986; Mason 1981). The Early Woodland stage for the general Midwest region includes the Marion phase and a later complex characterized by incised over cord marked ceramics that are associated with a variety of contracting stemmed and stemmed projectile points.

The earliest pottery in the Great Lakes region is Vinette I, appearing between 1313 to 1495 BC, with the earliest dates from the Batiscan site in Quebec (Tache and Hart 2013:366).The evidence for Early Woodland pottery manufacture in the western Great Lakes and Upper Midwest is known from a number of regional pottery styles similar to Vinette I-Fayette Thick wares including Schultz Thick (Michigan), Marion Thick (Illinois, Indiana, Iowa, and Wisconsin), and La Moille Thick (Minnesota) (Emerson 1986; Boszhardt et al. 1986). The Indian Isle phase in southwestern Wisconsin is also recognized as a Marion variant (Benchley et al. 1997: 108) Sites outside of Wisconsin with thick ware pottery have yielded radiocarbon dates between 500 and 600 BC, indicating the time of the initial Early Woodland in the Midwest (Boszhardt et al. 1986). The innovation of pottery is linked to decreasing mobility and intensification of plant food consumption, processing, and storage (Brown 1986). Pottery may have been initially used for certain foods and during certain seasons and likely represents an increased commitment to a variety of food processing and storage needs (Brown 1986; Stevenson et al. 1997).

Early Woodland is also recognized by a technological shift to stemmed and contracting points. Straight and contracting-stem varieties, including Waubesa Contracting Stem and Kramer Stemmed, initially appear during the Late Archaic (1700 BC to 400 BC) and continue into the Early Woodland (Pleger and Stoltman 2009:712). Stemmed point technology, recognizable as a stylistic change, may also represent a change in weapon technology and hunting strategies (Ozker 1982). The lack of notching on Kramer points, as well as the succeeding Waubesa points, suggests that they were intended to be readily replaced, perhaps in hopes that the tip would remain in the wound of the hunted animal (Boszhardt 2002; Stevenson et al. 1997:153). In the western Great Lakes and Upper Midwest, Kramer points appear by 600 BC and reach a maximum distribution by 500 BC (Emerson 1986). Kramer points are strongly associated with Marion ceramics but may have a wider distribution (Benchley et al. 1997:108; Munson 1982; Ozker 1982). The association of Kramer points with thick Early Woodland pottery is best documented in the Illinois River valley and in Michigan, at the Schultz site (Boszhardt et al. 1986).

Some researchers associate Marion thick wares as the ceramic component of Red Ochre (Boszardt 1986; Munson 1982). Based on the number of radiocarbon dates documenting the synchronism of the Red Ocher mortuary complex with Marion, including dates from excavations at the Tillmont site in southwestern Wisconsin, Stoltman and Hughes (2004:758) argue that Marion and Red Ocher are two components of the same archaeological "culture".

Evidence for Early Woodland mounds construction is sparse north and west of the Ohio Valley and Early Woodland mortuary sites are rare in all Midwest regions (Brown 1986; Overstreet 1993). Burial mound construction appears in the northern portion of the Midwest, likely spreading from Ohio, along the southern Great Lakes into the eastern fringes of Iowa (Emerson 1986). Early Woodland mounds are known in southeastern Wisconsin (Hilgen Springs) and in Michigan

(Croton Dam) (Van Langden and Kehoe 1971). In Wisconsin, the earliest thick pottery is found in the southern portion of the state occurring at least as far north as the Lasleys Point site on the east shore of Lake Winneconne (Overstreet 1993:150). The Lasleys Point thick ware has been dated to 2500 ± 40 BP or 2-sigma cal 793-486 BC (Richards and Jeske 2015). The origins of thick wares in Wisconsin is thought to have occurred from east to west, spread along the southern Great Lakes or from the southeast through Illinois (Salkin 1986).

In the Upper Midwest, varieties of pottery and projectile points/knives represent later developments of the Early Woodland period (Boszhardt et al. 1986). Later pottery styles exhibit an elaboration of fingernail impressions, sometimes occurring with incised lines that may be combined into rather complex designs on the vessel exteriors. Other decoration techniques include circular punctations, applied to the exterior or interior forming a node or boss on the opposite vessels wall, and cord-wrapped stick impressions on the interior lip. Vessel bases shift from flat to rounded points (conoidal). In eastern Wisconsin, this pottery type is referred to as Dane Incised. In southwestern Wisconsin, these incised vessels, known as Prairie Incised, are often tempered with sand. Radiocarbon dates indicate a time span of about 200 BC to AD 100 for these wares (Boszhardt et al. 1986). However, dates in excess of 400 BC have been reported from sites in northern Wisconsin including Squirrel Dam (Jeske and Richards 2009; Moffat 1999) and Shanty Bay (Dirst 1998).

Associated with this later phase are contracting stemmed points, typified by Waubesa contracting stem, rather than the straight stemmed Kramer points (Boszhardt et al. 1986).

The incised over cord marked ceramic assemblages share an affinity with, or are a part of, the Black Sand culture or horizon defined in Illinois (Benchley et al. 1997). The incised over cord-marked complex is widespread over the upper Midwest during the Early Woodland period and many variants are known (Benchley et al. 1997; Salkin 1986). These types include Black Sand, Dane Incised, Prairie Incised, Waubesa, and Beach Incised (Salkin 1986; Stoltman 1986). In portions of the Great Lakes region, Marion phase artifacts are less common suggesting that Early Woodland incised-over-cord-marked ceramics share closer affinity to groups from the far south or north. Hall (1950:20) has argued that Midwestern incised over cord marked ceramics have a far southerly origin in the Alexander culture of southern Tennessee and northern Alabama. Alternatively, Munson (1982:12) believes incised over cordmarked ceramics originated in the northeastern/ southwestern Wisconsin/southern Minnesota area, and their appearance in some assemblages is due to seasonal incursions from the north (Salkin 1986: 117). Although the origin of these incised over cord marked variants is much debated, the diversity of the ceramic styles suggests a complex situation (Brown 1986: 601). This diversity may reflect an increasing regionalization of groups, in situ development from local Late Archaic populations, and/or influences from inter-regional group interaction during the Early Woodland. The end of Early Woodland occurs around AD 100 with the onset of new cultural developments in southern Ohio and Illinois that influence a broad area of the Midwest and are subsumed under the Middle Woodland period (Boszhardt et al. 1986).

Early Woodland in Southeastern Wisconsin

The Early Woodland period (ca 500 BC to AD 100) for southeastern Wisconsin is consistent with the cultural historical scheme developed for the general Midwest to include an earlier Marion-related phase and a later complex characterized by incised over cord-marked ceramics (Benchley et al. 1997; Emerson 1986; Green and Schermer 1988; Munson 1982; Salkin 1986).

Early Early Woodland

The distribution of Marion Thick and similar flat-bottomed pottery in Wisconsin is restricted to the prairies and deciduous forests of the southern half of the state (Boszhardt et al. 1986).There is limited evidence for the early portion of the Early Woodland in southeastern Wisconsin, with sites presenting as a sparse scattering across the landscape (Boszhardt et al. 1986; Overstreet 1993). In southeastern Wisconsin, as for the rest of the state, Marion thick pottery has been recovered from plowed sites but from very few excavated contexts (Boszhardt et al. 1986).

The Marion-related phase is defined by the initial use of ceramic container technology, distinctive grit-tempered thick conical forms and stemmed Kramer points; there is evidence that burial mound mortuary ceremonialism also appears during the Early Woodland period (Kehoe 1975; Van Langen and Kehoe 1971). Marion Thick pottery is grit-tempered, cord-paddled inside and out, with a short, squat, flat based jar vessel form (Overstreet 1993). Decoration is limited, consisting mostly of cordmarked or cord-roughened exteriors and transverse interior cordmarking. Other decoration is generally limited to the flat lips of the vessels and less frequently to the exterior of the body and consists of fingernail or tool impression (Boszhardt et al. 1986; Overstreet 1993).

Marion Thick and Kramer points have been recovered from plowed fields across southern Wisconsin; however, few cohesive early Early Woodland occupations have been excavated and reported (Benchley et al. 1997:108). Kramer points, although found throughout the region, occur in much lower numbers than later point types (Stevenson et al. 1997). Marion Thick pottery is very scarce, sometimes occurring as a scattering of sherds (Stevenson et al. 1997). The sites referenced by Benchley et al. (1997) as having early Early Woodland occupations that have been excavated and reported on include the following: Hilgen Spring Mound Group (47OZ007), Robert Grignon Trading Post (47WN0676). Bachmann (47SB0202), and Blair's Spring Site (47WN0428) (Mason and Mason 1991).

The most notable early Early Woodland site in southeastern Wisconsin is the Hilgen Springs Mound group, a group of three conical mounds overlooking a tributary of the Milwaukee River (Boszhardt et al. 1986; Kehoe 1975; Van Langen and Kehoe 1971). The mounds contained human and dog burials, hearths and fire pits, and, in one mound, five rock constructions or features of various shapes and sizes (Boszhardt et al. 1986). Dates from wood charcoal on the mound floor and in the mound fill yielded calibrated medians of 949 BC, 611 BC, and 522 BC However, not all archaeologists accept the Early Woodland origin of the mounds (Boszardt et al. 1986:252).

Based on the scarcity of earlier sites and artifacts, the Early Woodland stage did not explode across southeastern Wisconsin, nor were there major changes in population or subsistence (Stevenson et al. 1997).

Later Early Woodland

The latter portion of the Early Woodland is marked by the appearance of incised over cord marked ceramic assemblages that share affinity with, or are part of, the Black Sand horizon (Brown 1986; Munson 1982). As elsewhere in the Midwest and Great Lakes region, the latter part of the Early Woodland period in southeastern Wisconsin is recognized by a shift in pottery technology and a change from square stemmed projectile points (Kramer Stemmed) to Waubesa Contracting Stem points. Late Early Woodland ceramics are sand or grit-tempered cord-marked jars with relatively thinner walls and slightly everted upper rim profiles. Decoration is applied directly over cord-marking in the form of bosses, incising, fingernail impressions and cord-wrapped-stick impressions, sharing affinity with the Black Sand horizon of Illinois. Based on increased regional differentiation typologically evidenced in ceramic decorative variation, archaeologists have identified several distinct late Early Woodland phases in Wisconsin. These phases include the Prairie phase in southwestern Wisconsin (Stoltman 1990), the Lakes Farms phase along Lake Waubesa and the Deer Creek focus along Lake Koshkonong (Rock River) in southeastern Wisconsin (Salkin 1986), and the provisional Onion River phase (Rusch 1988) in eastern Wisconsin.

Late Early Woodland settlement patterns included large warm-season (spring-summer) camps, frequently sited on floodplains, surrounded by specialized resource processing and extraction sites (Overstreet 1993; Rusch 1988). During the fall-winter months, individual families dispersed from the large camps, spreading out across the landscape and into more protected environments. Goldstein (1987, 1993) suggested that, during the Woodland continuum, site locales were repeatedly visited during the fall/winter months with occupations during other seasons occurring outside the region.

The Henschel site (47SB0029), situated along the northern margin of the Sheboygan marsh, has been interpreted as an Early Woodland residential base camp that was occupied from spring through fall (Richards, Overstreet, and Richards 1993). Smaller Early Woodland fall/winter camps are known from several sites within southeastern Wisconsin, notably Bachmann (47SB202) along the Onion River in Sheboygan county, the Beach site (47DA459) on the shores of Lake Waubesa (Yahara River) in Dane County, the Plantz site (47WN0325) along Rush Lake in Winnebago county, and the Finch site (47JE0902). The Bachmann site is a small winter camp, with activities focused on the intensive processing of white-tailed deer. At the Plantz site (47WN0325), the late Early Woodland component defines a fall season extraction camp for the harvesting and processing of wild plant food and nuts (acorns and walnuts) (Meinholz and La Fleur 2006). At the Beach site, as well as at the Henschel site, distinctive food processing and storage-related pits appear during the Early Woodland.

Prior to the Finch site excavation, no houses had been identified at Early Woodland archaeological sites in southeastern Wisconsin. A few possible Early Woodland houses have been identified in other areas of Wisconsin including the Kieler I site in southwestern Wisconsin (Jones and Harvey 2010), the Old Spring site in Winnebago county (Richards et al. 1993), and at the Bruner-Schmidt site (Overstreet 1993). Theses houses tend to be oval in planview and basin shaped in profile encompassing an area between 3.1 to 11.5 m^2. At Kieler I, a second house type, defined by a C-shaped ring, may also be present (Jones and Harvey 2010). The Early Woodland house at the Finch site is a roughly oval to rectangular shallow basin form encompassing about 6.76 m^2 (Haas 2019).

Early Woodland sites in southeastern Wisconsin tend to occur within the same locales as later Middle and Late Woodland sites (Goldstein 1987, 1993). The preferred location for Woodland-era sites are along interior bends of rivers near stream confluences, and close to wetlands, within oak openings and forests. Wetland resources, characterized by abundancy and stability especially during the winter months, were of particular importance to Woodland groups (Goldstein 1992).

Early Woodland subsistence economies are very poorly understood but are generally thought to consist of seasonally mobile foragers relying on a variety of wild plant foods and mammals, complemented by other fauna (bird and aquatic species) (Salkin 1986; Salzer 1965; Stencil 2015; Stevenson et al. 1997; Wiersum 1968). Based on the Finch site, Early Woodland economies were oriented to harvesting nut resources, especially black walnuts and acorns, and processing of medium/large and large mammals, including white-tailed deer, elk, and wolf/coyote/dog (Haas 2019; Stencil 2015). Although economic data is sparse, seed cultivation is speculated to have been part of the subsistence practices for Early Woodland groups based on data from outside the region (Goldstein 1992). Domesticated *Iva annua* var. *marcracarpa* (sumpweed) and *Helianthus annus* (sunflower) were recovered from Early Woodland contexts at the Bachmann site (Zalucha 1988). Low quantities of squash rind were also recovered from the Finch site (Haas 2019).

Early Woodland mortuary sites in the Midwest are rare in nearly all regions (Charles et al. 1986; Emerson 1986; Overstreet 1993:119). Red Ochre has been associated with the early part of the Early Woodland, as have the conical mounds at Hilgen Springs Mound Group. The mortuary practices associated with the later portion of the Early Woodland in Wisconsin are very poorly known.

Currently, three regional phases are recognized for southeastern Wisconsin during the latter portion of the Early Woodland: Lakes Farm, Onion River, and Deer Creek. The phases are largely defined on the basis of distinctive ceramic decorative treatments and geographical location.

Lakes Farms Phase. The Lakes Farm phase is situated on Lake Waubesa (Yahara River) in Dane county and was developed from excavations at three sites: Beach site (47DA459), Canoe Site (47DA4597), and the Airport Village site (47DA0002) (Baerris 1952; Salkin 1982, 1986, 1994). Wood charcoal from a pit feature containing a Beach Incised vessel from the Beach site yielded a calibrated median AMS date of AD 74 (calibrated range 101 BC to AD 244).

Salkin (1982, 1986) identified Waubesa and Beach series ceramic types and Waubesa contracting stemmed points as diagnostic indicators for the Lake Farms phase. Beach and Waubesa Incised ceramics share affinity with both Dane Incised and Prairie Incised ceramics yet remain a locally southeastern Wisconsin diagnostic manifestation. The Beach Incised series are compared with Fettie Incised ceramics of central Illinois, possibly signaling a south to north cultural diffusion from Illinois to Wisconsin (Salkin 1986; Stevenson et. al. 1997: 156). Diagnostic Waubesa Contracting Stemmed and Kramer Stemmed points were also recovered from the Beach site's Early Woodland component (Salkin 1986: 102, 104). Other chipped stone artifacts include drills, scrapers, and knives, similar to tools associated with the site's Late Archaic and later Woodland occupations. Ground stone includes celts and axes. A copper awl was recovered from the Beach site and several copper items were also found at Early Woodland sites in Dodge and Dane Counties (Stevenson et al. 1997).

Settlement patterns, consistent with broad regional trends, involved large spring to fall base camps and smaller habitation sites in more protected environments during the fall/winter months. Lake Farms phase sites are associated with wetland and shallow lake environments (Salkin 1986:112). Small fall/winter campsites are well-represented in the archaeological record (Stevenson et al. 1997). No traces of houses have been identified at Lake Farms phase sites.

As seasonally mobile hunter-gatherers, subsistence economies included a variety of wild plant and animal resources. Faunal resources consist of mammals (white-tailed deer, elk, squirrels), birds (turkey, duck), and turtles, with limited evidence for fish and shellfish (Salkin 1986; Stevenson et al. 1997). Plant food evidence indicates a variety of nuts and some seed plants. At Elmwood Island, weedy plant seeds such as bedstraw and goosefoot, were recovered (Stevenson et al. 1997). Salkin (1986: 112, 116) notes that horticultural activities likely supplemented the wild plant and animal resources.

Onion River Phase. Rusch (1988) has defined the Onion River phase based on excavations at the Bachmann site in Sheboygan County. Sites belonging to the phase may be identified by the presence of Onion River Incised pottery and Kramer and Waubesa projectile points. The spatial extent of the Onion River phase has not been fully defined (Overstreet 1993). The Bachmann site represents a winter hunting camp, yielding faunal remains that indicate intensive processing of white-tailed deer, although moose, beaver, and raccoon are also represented (Rusch 1988). Sumpweed and sunflower seeds were recovered from the site, producing the only evidence of Early Woodland seed processing and cultivation in southeastern Wisconsin. Sumpweed and sunflower, along with other plants, were cultivated elsewhere in the Midwest as early as 2000 BC (Stevenson et al. 1997). Three radiocarbon dates, all from wood charcoal within pit feature fill, yielded calibrated AMS median dates of 72 BC, 107 BC, and 400 BC (Rusch 1988).

Deer Creek Focus. The Deer Creek focus was defined by Salzer (n.d.) as the precursor to the Waukesha phase and was largely based on the excavations of the pre-Middle Woodland levels at the Highsmith site (47JE004) along the Rock River. Salzer (n.d.) identifies several other sites as having a Deer Creek component including Hahn I (Keslin 1958), Kutz, Hahn II, Airport Village, Horicon site, Outlet, Cooper's Shores, and Catfish Village. Using stylistic criteria, Salzer (n.d.) subsumes ceramics of the Deer Creek focus, including Dane Incised, Dane Punched, Dane Cord Marked, and Deer Creek Incised, under Outlet ware. Sazler (n.d.) further associates Outlet ware as within the range of variation for Black Sand. Decorative techniques on Outlet ware consist of parallel or trailed incised lines applied at the neck and rim in simple geometric patterns, fingernail stamping, and/or nodes/bosses. Lithic tools are typically manufactured from local materials and there is evidence for bone tool technology. Features associated with the phase are rare; however, Salzer (n.d.) identified one hearth from the Highsmith site and a deep burial pit at Hahn I as Deer Creek phase features. Although there are no radiocarbon dates for the Deer Creek focus, Salzer (n.d.) suggests the phase is contemporary with Black Sand in Illinois, generally from 450 to 200 BC (Salzer n.d.; Struever 1968). Salzer (n.d.) notes that in other areas of the state marginal to the center of the Waukesha focus, Deer Creek may have persisted later in time.

Middle Woodland

Middle Woodland refers to a wide variety of archaeological cultures throughout eastern North America that date to between 200 BC and AD 500 (Abrams 2009; Stevenson et al.1997). General characteristics shared among these Middle Woodland groups include the construction of conical burial mounds, cultivation of local plants, and decoration of pottery using pressing tools such as notched bone or cord-wrapped sticks (Stevenson et al. 1997).

Middle Woodland in the Midwest is nearly synonymous with Havana-Hopewell and Hopewell. Archaeologically, Hopewell is typically recognized by a heightened scale of the construction of earthworks, the distribution of non-local materials, finished goods, and distinctive symbolic elements, evident on a variety of media, that occur across a broad region of the mid-continent (Abrams 2009; Braun 1986). Hopewell, long since considered as a single culture or singular social identity, encompasses a great amount of cultural variability in space and time, referencing a diverse set of Middle Woodland societies each internally bound through several diverse spheres of alliance (Abrams 2009; Brown 2005; Carr and Case, 2006; Greber 1991; Pacheco 1996; Pacheco and Dancey 2006). This diversity suggests that Hopewell should be viewed as a broad interaction sphere that connected local communities in different ways and to different degrees (Carr and Case 2006; Seeman 1995; Struever 1964).

Two primary centers are recognized with Ohio Hopewell centered in southeastern Ohio and Havana-Hopewell situated within the central and lower Illinois River valley. Havana-Hopewell and Hopewell influence extended over a broad area from the Eastern Plains to the Atlantic, including Wisconsin (Goldstein 1982; Jeske 2006). Many of the Middle Woodland groups were connected with one another through a large, inter-regional network referred to as the Hopewell Interaction Sphere (Struever 1964). Originating in Illinois and Ohio, Hopewell influenced large areas of central and eastern North America. Hopewell is characterized by large earthen mounds and the use of exotic raw materials such as mica, steatite, and black bear teeth from Appalachia, Galena chert from the Upper Mississippi Valley, obsidian from Yellowstone, copper and silver from the Great Lakes area, and marine shell from the Gulf and Atlantic coasts. Hopewell assemblages also include non-utilitarian grave goods and other artifacts made from imported and local materials, complex burial mounds, elaborate mortuary processing facilities, and large geometric earthworks (Bolnick and Smith 2007; Braun 1979; Brose 1994; Brown 1979; Carr and Case 2006; Chapman and Keel 1979; Charles and Buikstra 2006; Fischer 1974; Ruby 2006; Walthall et al. 1979). Interregional trade networks facilitated the exchange of raw materials and finished goods, most of which ended up in non-mortuary caches or in burial mounds as grave goods (Braun 1986; Fie 2006; Seeman 1979; Struever and Houart 1972).

Hopewell communities also gathered periodically for ritual interaction at corporate spaces containing large earthworks, wooden architecture, and/or communal burial facilities (Charles 1995; Pacheo and Dancey 2006; Seeman and Branch 2006). These spaces may have been built and used by lineage based descent groups, local communities made up of several kin groups, non-kin based world renewal sodalities, or members of different communities (Carr and Case 2006). Hopewell communities also shared some ideological, religious, and/or philosophical perspectives, which were expressed in their cultural practices, artifact forms, and stylistic motifs (Byers 2004; Carr and Case 2006; Pacheco 1996; Fie 2006; Seeman 1995).

A number of related cultures are known for the area north of primary Havana-Hopewell and Hopewell centers in the Illinois and Ohio River valleys. These cultures share basic traits with Havana-Hopewell and Hopewell, especially relative to ceramic and lithic technology and patterns of mortuary behavior. In the Great Lakes region, Middle Woodland groups have been differentiated based on the varying degree of influence from the Hopewell centers in Ohio and Illinois, correlating with three latitudinal tiers: south, middle, and north (Mason 1981). Groups in the south tier were the most influenced by Hopewell (Havana and Scioto). Middle and north tiers reflect less influence from Hopewell connections to the south and show stronger associations with various groups to the east and west. Southern tier groups may have been more sedentary than middle and northern tier groups; middle and northern tier groups were adapted to a more mobile, hunter-gatherer lifestyle that had an emphasis on fishing (Brose and Hambacher 1999). Southeastern Wisconsin Middle Woodland, along with Trempealeau (southwestern Wisconsin), Norton (southwestern Michigan), and Squawkie Hill (western New York), represent "southern" tier groups and are described by Mason (2002) as having good representation in the Hopewell Interaction Sphere (Mason 1981). Hopewell influences on the southern groups are visible within ceramic and lithic style, mortuary programs, and subsistence-settlement traits. For some groups, this influence consists of Hopewell related ceremonialism that has been added to a locally defined way of life (Jeske 2006). For other southern tier groups, such as the Norton Tradition (southwestern Michigan/northwestern Indiana), the Hopewell influence may represent actual migrations of Hopewell people from the south and/or more intensive involvement in the Hopewell Interaction Sphere (Kingsley 1999; Mason 1981:241).

In Wisconsin, there at least three major adaptations during the Middle Woodland (Goldstein 1982). In northern Wisconsin, the Laurel tradition, the only "northern tier" group (Mason 1981), is defined by an adaption to Great Lakes shorelines and a reliance on fishing and fowling during the spring and summer, and winter hunting of moose, bear, caribou, beaver, and hare (Goldstein 1982; Mason 1966, 1967, 2002). In north central Wisconsin, Salzer has defined the Nokomis phase as an adaptation to the numerous inland lakes and streams that characterize this area (Salzer 1969). In southern Wisconsin, Middle Woodland groups have ties to the Havana tradition (Goldstein 1982). In southwestern Wisconsin, the Middle Woodland is known as the Trempealeau phase and later Millville phase (Freeman 1969; McKern 1931; Stoltman 1979). In southeastern Wisconsin, the Middle Woodland has been subsumed under the Waukesha phase, marked by less elaborate mounds and few grave goods as compared to southwestern Wisconsin (Goldstein 1982).

Waukesha Phase

The Middle Woodland period in south-central and southeastern Wisconsin is very poorly understood. The current cultural-historical framework posits that Middle Woodland groups in southeastern Wisconsin are derived from local Early Woodland antecedents that have a long history in the region (Goldstein 1992; Jeske 2006; Salzer n.d.). Middle Woodland is differentiated from Early Woodland based on the appearance of Havana-Hopewell-related lithic technological forms and stylistic concepts on locally produced ceramic containers, the occurrence of non-local ceramic vessels, a marked increase of exotic stone resource use, and proliferation of burial mound mortuary ceremonialism (McKern 1942; Salzer n.d.; Wood 1936). These material indicators situate the southeastern Wisconsin Middle Woodland populations within the extent of Havana-Hopewell influence (Mason 1981; McKern 1942; Salzer n.d.; Stevenson et al. 1997; Wolforth 1995). The Havana-Hopewell phenomenon in southeastern Wisconsin is envisioned as ideational aspects, stylistic elements, mortuary behavior, and practices mapped onto the material repertoire and lifeways of an indigenous population with a deep history of regional occupation (Goldstein 1992; Jeske 2006; Salzer n.d.). Middle Woodland populations in southeastern Wisconsin have been incorporated into the Waukesha Focus (or phase), understood as a regional variant and northerly expression of Havana-Hopewell (Bennett 1952; Griffin 1967; Jeske 2006; Mason 1981;McKern 1942; Salzer n.d.; Struever 1964; Wood 1936).

Wood (1936) provides one of the earliest references regarding the connection between groups occupying southeastern Wisconsin and Havana-Hopewell/Hopewell. Referencing the excavations at the Peterson site (47WK0199), located along the Fox River in Waukesha County, as well as artifacts (copper celts, platform and effigy pipes, and “rouletted” pottery) in the Milwaukee Public Museum collected from Waukesha County, Wood (1936) suggested the site may represent a Wisconsin Focus of the Central Basin (or Hopewellian) phase. Key to Wood’s (1936) identification of the Waukesha Focus identification were the early nineteenth century mound investigations at the Peterson site. The Peterson site defines a group of conical mounds that had been mapped by Increase Lapham (1855: Plate XV) and Peet (1890: Figure 137). In 1902, excavations of one of the mounds by Lafayette Emerson exposed a cobblestone burial chamber containing a primary internment and monitor type pipes (Brown 1923:93-94; West 1905:127). In 1936, salvage type investigations within another mound, undertaken by E.F. Wood and W.C. McKern, both of the Milwaukee Public Museum, identified a rectilinear burial pit with several interments and few associated artifacts (Wood 1936). The rectilinear pit had been covered by a localized stratum of charcoal and ashes, interpreted as the remnants of a pole and bark structure that had been ceremonially burned. Grave goods were limited to shell beads found in association with one individual (Wood 1936).

The Waukesha Focus was subsequently referenced in the early 1940s and 1950s by McKern (1942) and Bennett (1952). In 1942, McKern (1942) described the Waukesha Focus as one of three areas in Wisconsin that exhibited Hopewell influences, collectively representing the far northwestern border of the known Hopewell areas. These discontinuous areas, cited as foci in the Elemental Aspect of the Hopewellian Phase, included the Trempealeau Focus in southwestern Wisconsin along the Mississippi River, the Red Cedar Focus in Barron County of northwestern Wisconsin, and the Waukesha Focus in Waukesha County of southeastern Wisconsin (McKern 1942). Sites of the Waukesha Focus had been observed largely in Waukesha County along the Fox River, although McKern (1942) hints at a broader distribution.

In 1952, the Waukesha Focus was presented by Bennett (1952) as the northern frontier of Hopewellian development. This taxonomic placement was based upon the similarities of mound burial practices and ceramic stylistic traits between southeastern Wisconsin sites and the Hopewellian world, particularly with the northern Illinois Valley. Bennett (1952) emphasized that southeastern Wisconsin pottery stylistic traits exhibited stronger affinity with ceramics recovered from the Illinois Valley than with those vessels from the Trempealeau Focus of southwestern Wisconsin.

The most substantive research regarding the Waukesha Focus was completed by Robert Salzer and documented within an unpublished manuscript (Salzer n.d.). Salzer’s (n.d) synthetic treatment examined the extant archaeological literature and museum collections regarding Middle Woodland in southeastern Wisconsin (that formed the basis of his Master’s Thesis) and presented new archaeological data based on excavations from the Highsmith site and analysis of material remains from the Cooper’s Shores site that had been previously excavated by Robert Hall.

Table 3.3. Archaeological Sites and Collections Cited by Salzer (n.d.) in Support of the Waukesha Phase (continues).

Rock River/ Lake Koshkonong			
Site Name & Number	*Site Type*	*Description*	*Reference*
Milton Mound and Cooper's Shores (47RO0002)	Mound and Habitation	Mound group (Milton Mound) associated habitation site (Cooper's Shores)	Clark 1884; Hall 1962; Stout and Skavlem 1908
Highsmith (47JE0004)	Habitation	Habitation site.	Salzer 1965
General Atkinson Mound Group Schaefer Mound (47JE0.03)	Mound	Cultural material collected from mound fill adjacent to bird effigy mound (Mound 51)	Stout and Skavlem 1908
Popplow Cache (47JE0135)	Cache	Leaf shaped lithic implements (60-70) of dark brown flint found two miles north of Lake Koshkonong	Skavlem 1914:105
Sumner Cache	Cache	Blue to brownish hornstone disks (6) recovered from a field near Sumner	Brown 1906:54
Bonier Cache	Cache	Flint disks found along east side of Rock River two miles above Fort Atkinson, just north of Highsmith site	Brown 1909:12
Yahara River/ Four Lakes Area			
Site Name	*Site Type*	*Description*	*Reference*
Indian Hill Mound Group (47RO0001)	Mound	Linear, oval, and conical mounds associated with Catfish Village and possibly the Fulton Enclosure	Brown and Brown 1929; Lapham 1855; Skavlem 1914
Catfish Village (47RO0202)	Habitation	Village site associated with the Indian Hill Mound Group (47RO001)	Brown and Brown 1929
Fulton Enclosure (47RO0063)	Earthen Enclosure	Large oval earthen enclosure possibly associated with Catfish Village and the Indian Hill Mound Group	Lapham 1855
Outlet (47DA0003)	Habitation and Mound	Village site and group of conical mounds	Bakken 1949, 1950; Brown 1922; Lapham 1855; Whiteford 1949
Gillman Cache	Cache	Four small disks in the Wisconsin Historical Society collections recovered from the Four Lakes area	
Fox River			
Site Name	*Site Type*	*Description*	*Reference*
Big Bend Mound Group/ Nicolai Peterson Site (47WK0199)	Habitation and Mound	Conical mounds and associated habitation site	Lapham 1855; Brown 1923; Wood 1936
Waukesha Group/ Cutler Mounds (47WK0224)	Mound	Conical, linear, and lizard effigy mound group.	Lapham 1855; Brown 1923

Salzer (n.d.) defined the Waukesha Focus for the Middle Woodland period of southeastern Wisconsin as a series of small sites situated along the region's major drainageways: Rock River (Lake Koshkonong), Fox River, Yahara River (Lakes Monona, Mendota, Waubesa, and Kegonsa), the Root River, and along the Lake Michigan shoreline (Table 3.3; Figure 3.2). The Waukesha Focus denotes a period of time when material culture reflects Middle Woodland styles and concepts from the south, distinguishable by domestic lifeways (especially ceramic vessel styles), mound mortuary programs, and extensive extra-regional social relationships. The origins of the Waukesha Focus emerged locally, from regional Early Woodland antecedents that Salzer (n.d.) subsumed under the Deer Creek Focus. Although Salzer (n.d.) noted that the Waukesha Focus might be reasonably extended into northern Illinois, he restricted his discussion to southeastern Wisconsin.

Table 3.3. Archaeological Sites and Collections Cited by Salzer (n.d.) in Support of the Waukesha Phase (concluded).

Root River			
Site Name	*Site Type*	*Description*	*Reference*
Racine Group and Enclosures: Hoy and Bluff Groups (47RA0020 & 47RA0014)	Mound	Extensive mound group, earthen enclosure, and semicircular embankments. Associated with Hoy Cache (47RA0094)	Lapham 1855
Hoy Cache (47RA0094)	Cache	Hornstone disks (30-40) found south of the Hoy and Bluff Group.	Lapham 1855; West 1905
Federerick S. Perkins Collections	Cache	Twelve cache blades including one of Dongola chert	
Lake Michigan			
Site Name	*Site Type*	*Description*	*Reference*
Sand Ridge	Village	Village site along shore of Lake Michigan east and south of Kenosha to state line	Gerend 1904

Note: The Highsmith site was excavated by Salzer in 1959 to 1961 but had not been documented by Lapham (1855), Peet (1890), Stout and Skavlem (1908), and Brown and Brown (1929).

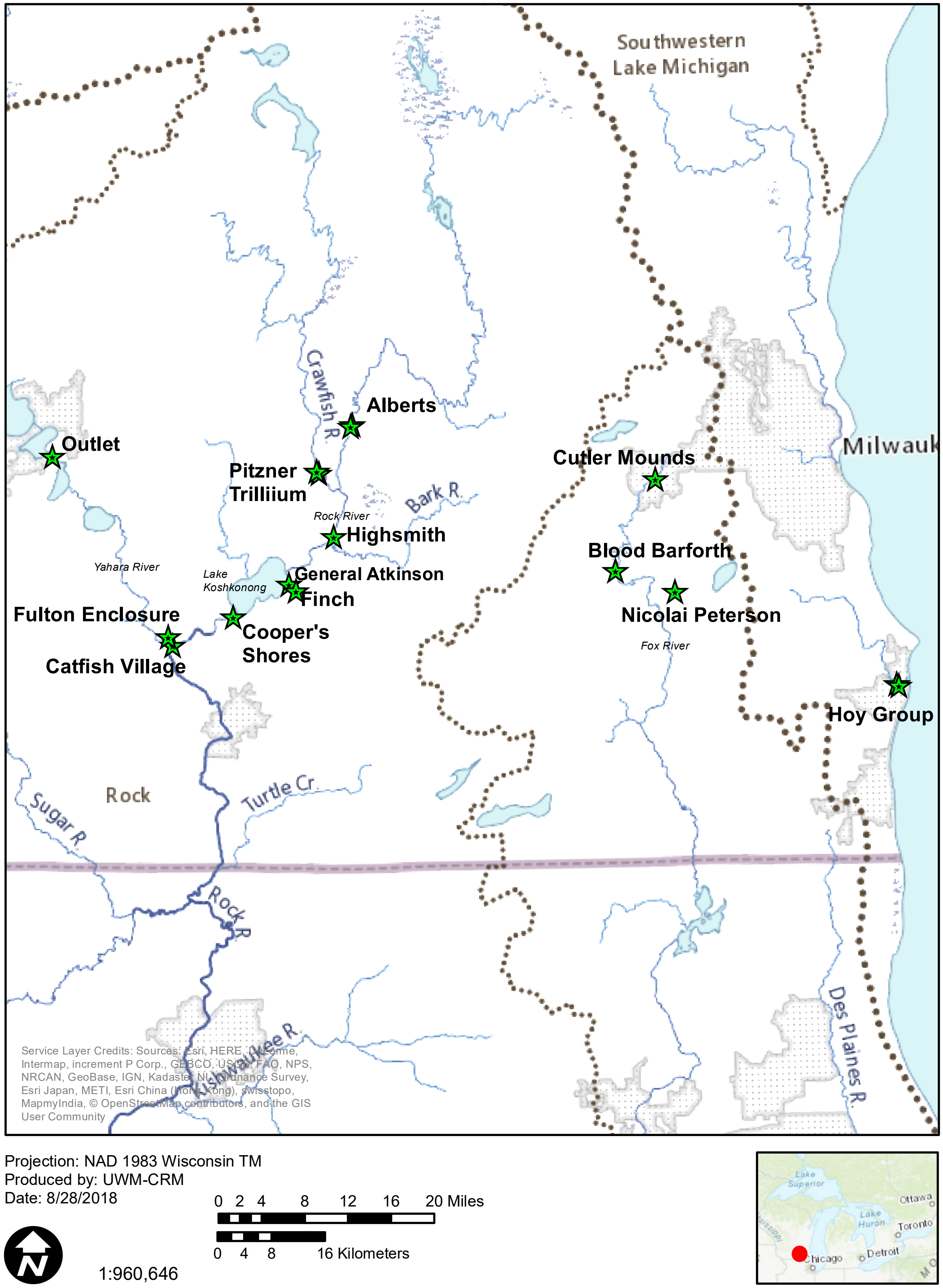


Figure 3.2. Select Middle Woodland sites in southeastern Wisconsin.

Subsequent to Salzer's excavations at Cooper's Shores and Highsmith sites, there have been few sites with substantive Middle Woodland components that have been subjected to archaeological excavations. Moreover, some of the larger scale archaeological excavations conducted in the region, although identifying Middle Woodland components, lack features that are attributable to the Middle Woodland and/or have been comprised by earlier and/or later site occupations. In southeastern Wisconsin, pre- and post- Middle Woodland occupations have not been distinguished at most multi-component habitation sites and stratified sites are not known (Benchley et al. 1997: 111). A review of WHPD data, indicates that only eight sites, including the Finch site (Haas 2019), have been subjected to some form of excavation and harbor cultural features clearly associated with a Middle Woodland occupation. These sites additionally include Alberts (Jeske and Kaufman 2000; Jeske 2006), Barforth Blood (Brazeau and Overstreet 1980), Brenton Schneider (Salkin 2003), Cooper's Shores (Wiersum 1968), Peterson (Brazeau and Overstreet 1980), Pitzner (Goldstein 1980a, 1980b, 1982), Plantz (Meinholz and LaFleur 2006), and Kohler (Jones et al. 2015).

Middle Woodland sites in southeastern Wisconsin represent seasonal encampments as well as large village sites, typically situated along wetlands and stream confluences (Goldstein 1992; Salzer n.d.). Middle Woodland sites are highly variable in terms of location, size, and appearance (Salzer n.d.). Substantial habitation sites with middens and pit feature have been identified along low riverine terraces and on high bluff tops along lake shores (Benchley et al. 1997). Some habitation sites are associated with mounded mortuary areas and earthwork enclosures. Based on the large scale surveys of the Rock and Crawfish River valleys, Middle Woodland settlement patterns are similar to that of the preceding Early Woodland with some evidence for increased residential stability (Salzer n.d.). This settlement pattern consists of fall/winter exploitation of wetland resources using dispersed camps and occupation of more permanent base camps or villages during the spring/summer months. These spring/summer base camps are situated along major rivers, near major wetland and stream confluences, and/or were located outside of the region (Goldstein 1992).

Although Middle Woodland houses are known in southwestern Wisconsin (Freeman 1969), northern Wisconsin (Salzer 1974), central Wisconsin (Hurley 1974), and from sites in northeastern Wisconsin (Birnbaum 2009, 2017; Clauter and Richards 2005), they are rare in southeastern Wisconsin. Only three sites have documented Middle Woodland structures: Brenton-Schneider (47RA0275) in Racine County (Salkin 2003), the Kohler site (47SB0153) in Sheboygan County (Jones et al. 2015), and the Finch site (Haas 2019). Brenton-Schneider, situated on a terrace adjacent to an inland marsh east of the Fox River and west of Lake Michigan, a 4.5 m^2 diameter circular structure was defined based on post mold patterns enclosing a shallow, basin shaped living floor (Salkin 2003). A Gibson/Clear Lake projectile point recovered "from within the circle of postmolds" tenuously associates the structure as Middle Woodland (Salkin 2003:40). A partial house floor defined by a two-meter diameter (4 m^2) circular stain, with a shallow basin shape in profile and possibly associated with post molds was identified at the Kohler site (47SB0173); pottery vessel form and paste characteristics were described as consistent with Middle Woodland and charcoal from the feature fill yielded a calibrated date of AD 425 to 595 (Jones et al. 2015:5-27) . At the Finch site, a circular house is defined by a flat bottomed shallow basin, encompassing an area of 3.6 m^2 (Haas 2019). Two Middle Woodland vessels (Sister Creeks Punctated and Havana ware vessels) were recovered from within the Finch house and three vessels (Naples Stamped, Kegonsa Stamped, and Shorewood Cord Roughened) were external to but directly associated with the structure (Haas 2019).

Middle Woodland domestic campsite/habitation have yielded cooking pits, refuse pits, post molds, and multi-functional pits. Cooking pits and hearths often contain copious amounts of wood charcoal, grit-tempered pottery, burned and unburned animal bone (medium/large mammal and fish), and charred nutshell fragments (hickory, walnut, hazelnut, and acorn) (Haas 2019; Meinholz and LaFleur 2006; Jones et al. 2015). Extensive middens, defined by thick accumulations of animal bone, pottery, waste flakes, stone tools, and wood charcoal, were identified at Highsmith (Salzer n.d., 1965), Cooper's Shores (Wiersum 1968), and Pitzner (Goldstein 1980a, 1980b, 1982). The middens at these sites were oriented along the bank of the Rock river and/or along a slope. Concentrations of pottery and food remains (animal bone, including fish and mussel shell) are noted at Pitzner (Goldstein 1980a, 1980b, 1982), Cooper's Shores (Wiersum 1968) and Finch (Haas 2019).

Middle Woodland in southeastern Wisconsin is recognized by changes in ceramic styles. Although the nodes and bosses present on Early Woodland wares persist, a new decorative technique of stamping, using a variety of dentate, rocker, and cord-wrapped stick forms, as well as zoned incising, and hemi-conical punctates, are present on Middle Woodland wares (Salzer 1986). Salzer (n.d., 1965) incorporated these decorative styles into the Rock ware typological class, defining a cluster of decorative elements, complexes, and vessel forms that are similar to Havana ware from the Illinois River Valley (Griffin 1952; Fowler 1955). These elements consist of dentate stamping, cord wrapped stick and plain stamping on exterior rim surfaces, interior lip beveling, interior rim channels, exterior nodes, and vessel form. Rock ware vessels are distinctive in terms of the precise manner in which these elements and designs are executed relative to vessel form and paste characteristics. Other than the inclusion of rounded pebbles, the paste characteristics of Rock ware are indistinguishable from Outlet ware. Salzer (n.d.) includes two previously defined types in the Rock ware category, Kegonsa Stamped and Shorewood Cord Roughened, and proposes Highsmith Plain as a new type (Baerreis 1952). Although Rock ware shares characteristics with Havana ware, and could be included within the range of variation for Havana ware, Salzer (n.d.) viewed the entire Rock ware assemblage as distinctive from Havana ware. Salzer (n.d.) further drew similarities between Rock ware and the Middle Woodland horizons at the Sauk County rockshelters (Wittry 1959). In addition to the newly defined ware types, Salzer (n.d.) identified Havana ware vessels and several Late Woodland ware types at the Highsmith site. The Havana ware vessels, with the exception of minor paste differences, were indistinguishable from the Illinois Valley vessels. Salzer (n.d.) indicates that some of the vessels were locally manufactured while others have paste characteristics suggesting a non-local manufacture. As such, Kegonsa Stamped and Shorewood Cord Roughened are local types derived from Havana forms. Other vessels common in Waukesha phase assemblages, such as Naples Ovoid-Stamped, Havana Zoned Dentate, and Neteler Crescent Stamped, are typical Havana types and considered non-local vessels.

Diagnostic chipped stone tools of southeastern Wisconsin Middle Woodland consist of a variety of stemmed and corner notched hafted bifaces (Stevenson et al. 1997). The Middle Woodland forms are more likely to be manufactured from non-local materials as compared to Early and/or Late Woodland types (Stevenson et al. 1997). Typological classes include Snyder, Steuben, Gibson, Manker, and Monona stemmed. Salzer (n.d., 1965), based on the excavations at Highsmith and Cooper's Shores, associates a marked increase in non-local raw material use during the Middle Woodland. A lamellar industry appears during the Middle Woodland; Most lameallar blades from Highsmith and Cooper's shores are of non-local materials (Salzer 1965; n.d.). Lamellar flakes define small blades produced from polyhedral cores and are found nearly exclusively in Middle Woodland contexts in southeastern Wisconsin (Goldstein 1982). A variety of other chipped stone tool types, such as scrapers, drills, knives, and flake tools occur at Waukesha phase sites (Stevenson et al. 1997).

Middle Woodland sites have yielded bone tools and copper artifacts. Salzer (1965; n.d.) notes a rather intensive bone industry at the Highsmith site consisting of awls/needles, turtle carapace bowls, antler flaking tools, socketed crude antler points, perforated deer phalanges, and cut and polished bone fragments. Few worked bone specimens were recovered from Finch that are associated with the Middle Woodland component (Stencil 2015). However, a perforated and polished raccoon canine was recovered from a Middle Woodland cooking feature in direct association with ceramic vessels.

Subsistence data from Middle Woodland sites in southeastern Wisconsin indicates a moderate to heavy emphasis on mammal and turtle resources with marginal exploitation of bird, fish and mussels (Lippold 1973; Salzer 1965, n.d.). At Highsmith and Cooper's Shores, hunting and shellfish gathering are well-represented in the faunal assemblage (Stevenson et al. 1997). The absence of grinding stones, fishhooks, and processing features (roasting pits) at Highsmith and Cooper's Shores led Salzer (n.d., 1965) to note that there was little evidence for wild plant food collecting and intensive fishing. Goldstein (1982) reasonably suggests that seed cultivation may have been part of the Waukesha phase diet despite the lack of evidence. The Finch site data indicates nutshell (hickory, acorn, and hazelnut) harvesting and processing, the use of squash, and intensive processing of medium/large mammals, especially white-tailed deer. Fish, turtle, and small/medium mammals (skunk, muskrat, raccoon) were also exploited by the Middle Woodland site inhabitants (Haas 2019; Stencil 2015). Squash rind and seeds provisionally identified as tobacco, recovered from the Finch site, provide the only evidence of domesticates from Middle Woodland sites in southeastern Wisconsin (Haas 2019).

Faunal remains from the Cooper's shores site reveal a predominance of deer, which appear to have been butchered off site with only the legs and head returned to the residential base (Benchley et al. 1997; Lippold 1973). The assemblage also included lower frequencies of elk, bison, beaver, muskrat, raccoon, domestic dog, wolf, bear, puma, and other small mammals, as well as fish, turtles, and mussels (Lippold 1973).

Waukesha phase mortuary sites consist of conical mounds, that occur on their own or in groups, and are known from sites such as Milton Mound, Outlet site, Big Bend, Waukesha Group, and the Racine Group. Middle Woodland mounds typically have tombs located near the center of the mound. Mound preparation involved the construction of a rectangular sub-floor pit in the center of the mound, that was sometimes covered with stone or burned wood/bark, and earthen ramps. The mounds often included more than one mode of burial. Although not common, materials recovered from mound contexts include large corner notched bifaces, bone pins, freshwater pearl and shell beads, cut and perforated animal mandibles, curved base platform pipes, pottery vessels, partial clay face coverings, and copper celts and beads (Goldstein 1982).

Other types of ritual sites are also known for people of the Waukesha phase. Along the Rock River in Jefferson County, the Alberts site complex (47JE0887 and 47JE0903) produced evidence of non-mortuary ritual behavior and landscape features (Jeske 2006). The center of a low conical mound, devoid of human burials and other indicators of mortuary ritual, contained a large boulder that had been placed on top of an intentionally burned Havana-like pot (Jeske 2006: 298-299).

Immediately adjacent to the crushed Havana vessel was a deep feature of clay and smooth pebbles. Adjacent to the mound area, a white clay deposit was identified at the base of a feature (Jeske 2006:302). Both white clay deposits were interpreted as relating to the Earth Diver mythology (Hall 1997; Jeske 2006:302).

In many instances, Middle Woodland mounds occur in mound groups that also contain Late Woodland mounds. This pattern of concordant sacred spaces, suggests that there may be cultural continuity over long periods of time in the region (Benchley et al. 1997). Based on the activities represented at the Alberts site, the patterning may also reflect long term continuity of local ritual belief (Jeske 2006:303).

Classic Hopewell Interaction Sphere items are rare at domestic Middle Woodland sites in southeastern Wisconsin and are typically represented by stylistic expressions on locally manufactured vessels, the presence of "trade" vessels, and non-local raw materials for lithic tool production and maintenance. From the Highsmith site, ceramic figurine fragments, unworked hematite, worked ochre (possibly used as pigment), a polished bear canine, and a perforated deer metatarsal from may represent Havana-Hopewellian items in a domestic context (Salzer n.d., 1965). A perforated and polished raccoon canine recovered from the Finch site may also represent an interaction item within a habitation context.

Cultural material derived from mortuary contexts, as described above, provides a more substantial link to Havana-Hopewell as compared to the domestic data. Although, as many researchers note, the types and quantities of materials from Middle Woodland mortuary contexts of southeastern Wisconsin are paltry relative to those recovered in southwestern Wisconsin (Golsdstein 1982; Salzer n.d; Stevenson et al. 1997).

The Middle Woodland period marks the first reported appearance of pipes from archaeologcial sites in Wisconsin (Sabo 2007; Stevenson et al. 1997). Curved and straight based platform type pipes are associated with Waukesha phase mortuary contexts in southeastern Wisconsin and have not been recovered in domestic contexts (Salzer n.d.). An analysis of Middle Woodland monitor type pipes at the Milwaukee Public Museum, indicates most are manufactured of Baraboo pipestone and Sterling pipestone, with few of Feurt Hill pipestone (Sabo 2007). The relative frequencies of Baraboo and Sterling pipestone evidences interaction of southern Wisconsin Middle Woodland inhabitants with Illinois Havana-Hopewell.

By about AD 400, Havana-Hopewell influences in southeastern Wisconsin had faded, replaced by more localized late Middle Woodland cultures (Stevenson et al. 1997). In portions of Illinois, these cultures are represented by the Weaver phase, which is related to the Millville phase of southwestern Wisconsin. In southeastern Wisconsin, the only evidence of late Middle Woodland occupations is a scattering of projectile points from multicomponent sites and the occurrence of Douglass Net-Impressed ceramics (Stevenson et al. 1997).

Steuben Phase

Researchers have noted a likely relationship between the Steuben phase of northern Illinois and the Waukesha phase of southeastern Wisconsin (Jeske 2006; Wolforth 1995). Diagnostic of the Steuben Phase are Steuben Punctated vessels; these vessels are straight sided jars with pointed bases, flared rims, and typically lack surface treatment. Decoration occurs at the rim consisting of conical, semi-circular, and ciruclar punctations (Wolforth 1995). Lip modifications, such as impressions and noding common on other Havana types, are notably absent on Steuben Punctated rims (Wolforth 1995). Steuben Punctated ceramics were manufactured during the middle and late phases of the Middle Woodland period and occur most frequently in the upper Illinois and upper Rock River valleys (Wolforth 1995).

Wolforth (1995) uses the occurrence and distribution of Steuben Punctated ceramics across northern Illinois (upper Illinois valley) and southern Wisconsin (Rock River near Lake Koshkonong), and dearth of such vessels in central and southern Illinois, southwestern Wisconsin, and Iowa, to delineate the southern Wisconsin/northern Illinois region as micro-style zone for Havana-

Hopewell. In this region, sites with Havana ware assemblages characterized by high frequencies of Steuben Punctated vessels represent an autonomous regional variant of the Havana Tradition during Hopewellian times (Wolforth 1995). A Steuben Punctated vessel from the Peterson site has been AMS dated to 1840±80 BP (2-sigma cal AD 8-AD 382) (Richards and Jeske 2015). Steuben Punctated ceramic vessels have also been recovered from the Cooper's Shores and Highsmith sites, and are reported from various sites in Jefferson and Rock counties (Jeske 2006). Steuben Puncated vessels, however, were not recovered from the Alberts or Finch site (Haas 2019; Jeske and Kaufman 2000; Jeske 2006).

Summary

This chapter provided the cultural setting for the Finch site by reviewing the regional archaeological data as well as the known cultural-historical record for the Early and Middle Woodland stages. A review of the state-wide archaeological site database as well as unpublished and published literature sources demonstrates that very few Early and Middle Woodland sites in southeastern Wisconsin have been subjected to some form of archaeological field investigation beyond an identification survey. Consequently, much of what is known for the Early and Middle Woodland stages couples data derived from the limited archaeological site record with trends that occur outside the region. Early Woodland in southeastern Wisconsin consists of an earlier stage, marked by thick wares and Kramer projectile points, and evidence for the initial appearance of conical burial mounds. The later portion of the Early Woodland is defined by incised over cord-marked ceramics, sharing an affinity with the Black Sand tradition, and Waubesa projectile points/knives. Settlement patterns of this later Early Woodland involved a seasonal-round of mobile foraging represented by large, warm season base camps and smaller campsite/resource extraction locales that were occupied during the winter months. A variety of wild plant resources, especially nutshell, were exploited along with medium/large mammals, including white-tailed deer, with some evidence for seed cultivation and domesticates (squash). Several distinct phases, Lakes Farms, Onion River, and Deer Creek, are recognized for the later Early Woodland in southeastern Wisconsin, distinguished on the basis of geographical location and distinctive ceramic wares.

The Middle Woodland in southeastern Wisconsin is synonymous with the Waukesha phase, recognized as the a northerly expression of Havana-Hopewell. The Waukesha phase was defined in the early 1900s largely based on mortuary data. Conical mounds, occurring singly and in groups, are known along the major drainages of the region and early excavations revealed submound chambers and burial artifacts reminiscent of Havana-Hopewell. Based on the mortuary data, and excavations at habitation sites conducted by Salzer (n.d.) in the early 1960s, southeastern Wisconsin is viewed as a northerly expression of Havana-Hopewell. Although not well known, Middle Woodland sites in southeastern Wisconsin represent seasonal encampments as well as large village sites, typically situated along wetlands and stream confluences. Subsistence data from Middle Woodland sites in southeastern Wisconsin reflects a moderate to heavy emphasis on mammal and turtle resources with marginal exploitation of bird, fish and mussels, and some evidence for domesticates (squash and possibly tobacco).

CHAPTER 4: FINCH SITE CONTEXT

Introduction

The Finch site is presented in this chapter, reviewing its location and excavation history and providing a summary description of the Early and Middle Woodland components. Activity areas associated with each component are detailed and the AMS record is discussed relative to the Early and Middle Woodland component. An analysis of lithic raw materials that correlate with each component is further provided, serving as a proxy for extra-regional interaction.

Location and Excavation History

The Finch site (47JE0902) is located in southeastern Wisconsin within Jefferson County, occupying a locally prominent hill and a small terrace adjacent to a spring fed pond east of Lake Koshkonong and the Rock River drainage (Figure 4.1; Figure 4.2). Prior to Euroamerican settlement, the pond was likely more of a marshy area (Brink 1835).The site encompasses 6,940 m^2 (1.7 acres) and is bounded by the pond to the east and agricultural fields to the north and south. The western boundary of the site is unknown as, at the time of the site identification in 1998, the alignment of WIS 26 arbitrarily established the western boundary (Watson et al. 2003). As no remnant of the site was identified west of WIS 26, the original construction of the highway in 1926 may have destroyed a portion of the site. The Finch site was part of an archaeological mitigation project prior to the highway expansion of WIS 26 in 2012 and no portion of the site currently remains extant.

Based on documentary research, the Finch site was originally reported as a small, historic-era (circa 1830 to 1850) Euroamerican cemetery plot associated with the Finch family (Rusch 1989). Although exhaustive efforts to physically locate the cemetery were largely unfruitful, archaeological studies conducted prior to the 2012 highway road construction identified a substantial subsurface scatter of prehistoric Native American archaeological materials unrelated

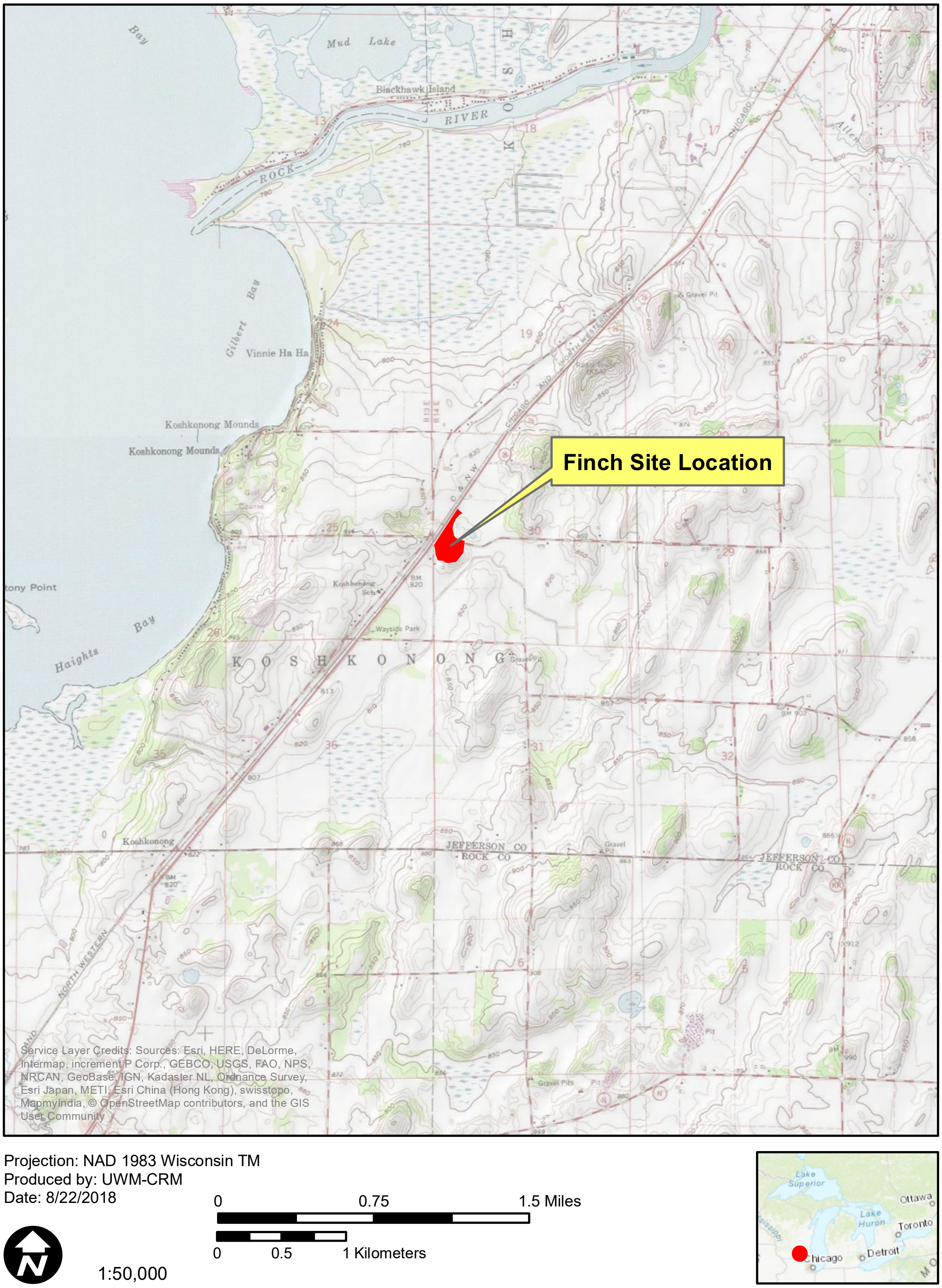


Figure 4.1. Location of the Finch site in southeastern Wisconsin.

to the historic Euoramerican cemetery but within its reported locale (Haas et al. 2015; Watson et al. 2003). In 2002, archaeological testing revealed dense concentrations of lithics, ceramics, and cultural features, all derived from an unplowed context, and of Middle Woodland and Late Woodland affiliations. Given the significance of the archaeological site, large scale excavations were undertaken from 2009 to 2012 in advance of the WIS 26 highway expansion project construction. These excavations, described below, yielded evidence of intermittent domestic habitations that occurred over the course of several millennia, with notably substantive Early, Middle, and Late Woodland occupations. Although these excavations yielded no evidence of the Finch family burial plot, a remnant of the Finch family cemetery was encountered partially beneath the road bed and roadway ditch (Haas et al. 2015).

Figure 4.2. In progress excavations at the Finch site.

The 2009 to 2012 archaeological mitigation investigations at the Finch site hand-excavated just over 1,200 square meters, yielded well over 100,000 artifacts and identified 153 cultural features (Figure 4.2). Given the large site size and the number of excavation units, the excavation units were grouped into five blocks (or regions), designated as A through E, to facilitate further description and analysis (Figure 4.3). The Finch site material culture assemblage includes high quantities of ceramics, well preserved ecofacts (faunal remains and plant macroremains), chipped stone artifacts, ground stone, and fire-cracked rock. High feature density, including hearths, pits, and structures, further characterize the site. A comprehensive site report, detailing the excavations and providing a basic suite of material culture analyses, has been completed for the Finch site as part of the cultural resource management project (Haas 2019). In addition, the Finch site vertebrate faunal assemblage was the focus of a Master's thesis project (Stencil 2015).

Diagnostic material culture indicates a multi-component site harboring Early and Late Paleoindian, Early, Middle, and Late Archaic, and Early, Middle, and Late Woodland components. Based on artifact densities, the Early Paleoindian, Late Paleoindian, and Early Archaic components are fairly ephemeral. Beginning in the Middle Archaic, components are more substantive, likely reflecting an increasing frequency of use of the site through time (Haas 2019). All of the archaeological data from Finch has been digitized into an ArcGIS geodatabase that is linked to the artifact database in Microsoft Access.

Site Formation and Structure

Cultural material was generally recovered between 0 to 70 cm below the surface (cmbs), generally within the lower portion of the sand loam A-horizon and upper portion of the sandy clay loam B-horizon soils (Figure 4.4). Geomorphological investigations confirmed that the Finch site sits on the rim and side-slopes of a kettle basin formed in late-Wisconsinan till. The cultural deposits are contained within buried contexts in loamy and fine-sandy pebble free sediment that composes a 30 to 40 cm thick mantel above the till (Figure 4.5). The presence of a pebble free mantle on the rim of the basin is attributed to biogenic processes that have formed a biomantle, a site-formation

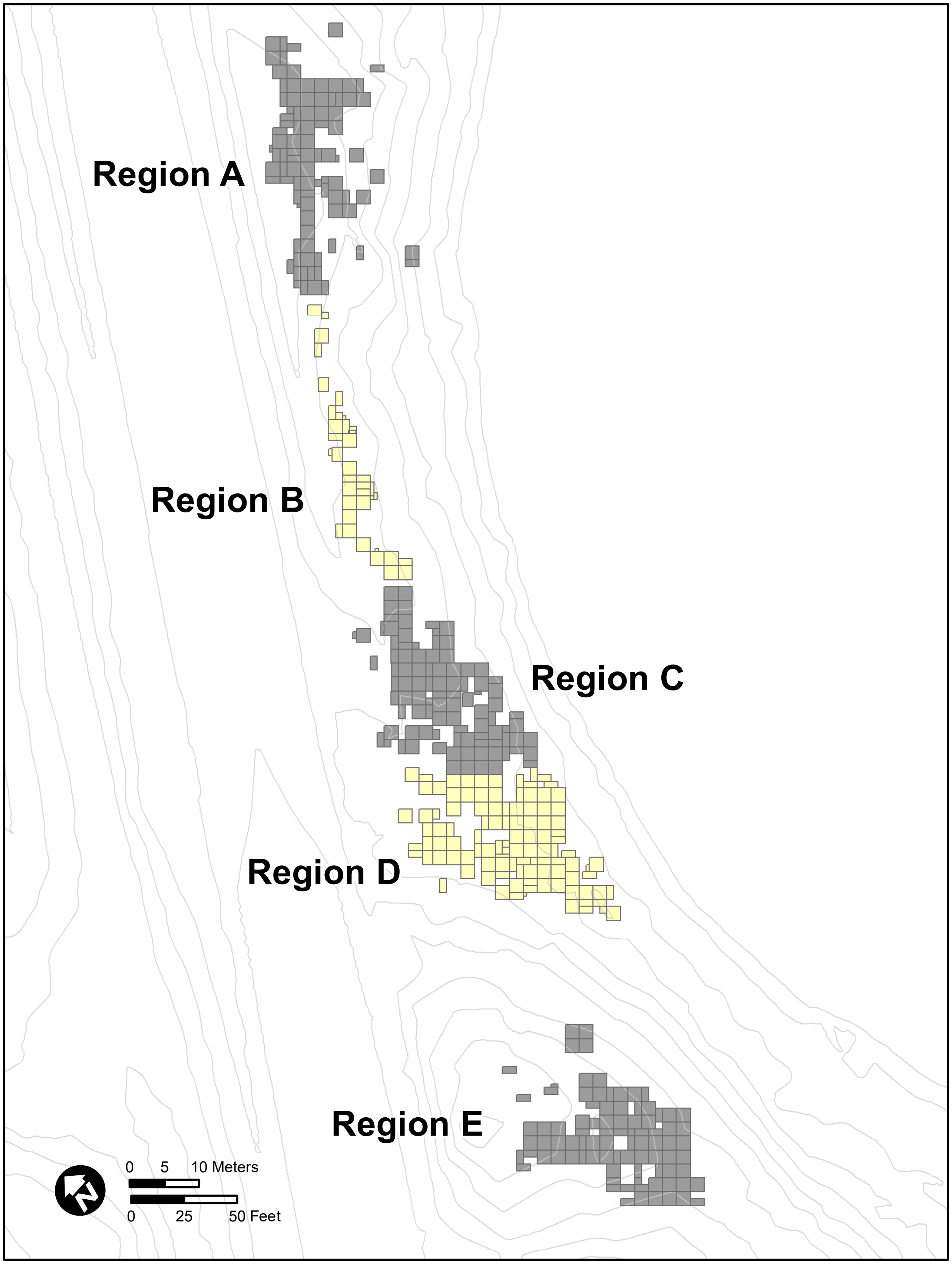


Figure 4.3. Overview of the Finch site excavations delineating the blocks (or regions).

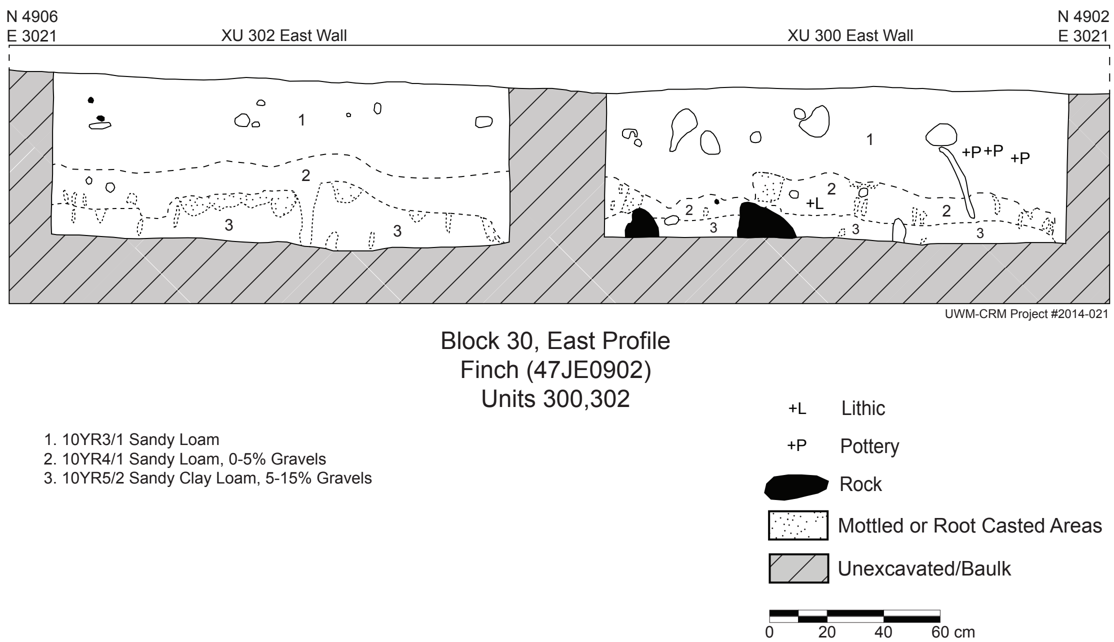


Figure 4.4. Typical excavation unit profile at the Finch site, Unit 300 and 302 in site region D.

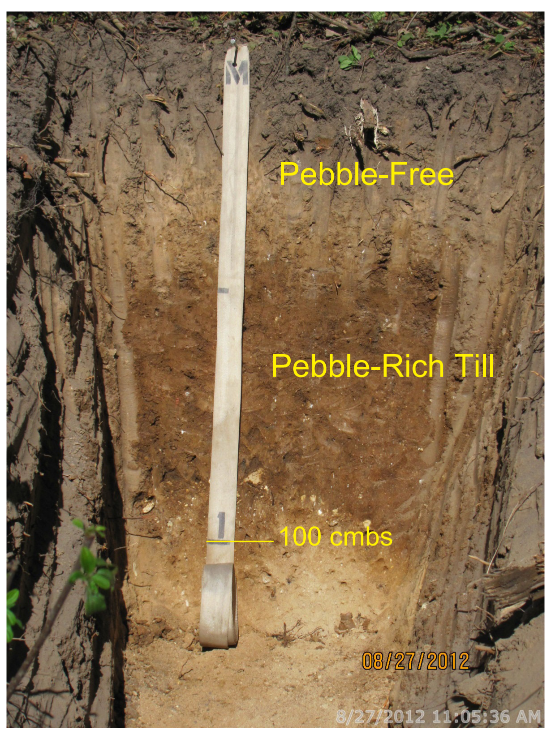


Figure 4.5. Typical stratigraphic profile from the Finch site.

process that accounts for stratified cultural deposits on stable geomorphic surfaces. As such, the cultural deposits have the potential to retain relative vertical integrity with older deposits found deeper in the stratum than younger deposits.

As part of the cultural resource management project to assess vertical patterning, the location and depth of each diagnostic artifact (lithic or ceramic) was plotted in ArcGIS and a series of tables and graphs were generated for each cultural temporal component on a site wide basis as well as for each site region (Haas 2019). The vertical patterning for the ,site as a whole, revealed vertical mixing of components, so that diagnostics of older components tended to occur at a shallower depth than younger components (Figure 4.6). Although a geomorphologically stable surface, biogenic processes, or the cumulative actions of burrowing rodents, insects, worms, and plants, have resulted in a certain extent of vertical mixing of the cultural material (Bocek 1986; Vogel 2012). In essence, the Finch site represents a palimpsest of artifact data created by cultural material deposition relating to a number of discrete occupations of various duration. In Regions C and D, however, the diagnostic artifact patterning indicated some correlation between depth and time of site occupation, especially with regard to the Late Archaic, Early Woodland, Middle Woodland, and Late Woodland diagnostics (Figure 4.7). The relatively small sample size of Paleoindian, Early Archaic and Middle Archaic diagnostics may have skewed the patterning in Regions C and D (Haas 2019). The presence of some indication of stratigraphic integrity within site regions C and D has implications for the Early and Middle Woodland site structure, as this site area was the focus of activities for the Early and Middle Woodland components.

As vertical provenience was determined to be insufficient to discriminate between successive cultural-temporal components, quantitative spatial analysis was conducted to identify the horizontal site structure associated with the Middle Archaic through Late Woodland cultural-temporal components (Haas 2017, 2018). The Paleoindian and Early Archaic components were excluded from the spatial analysis owing to their small sample size. The diagnostic artifact point patterns were explored using two quantitative methods: (1) spatial data analysis; and (2) local statistics.

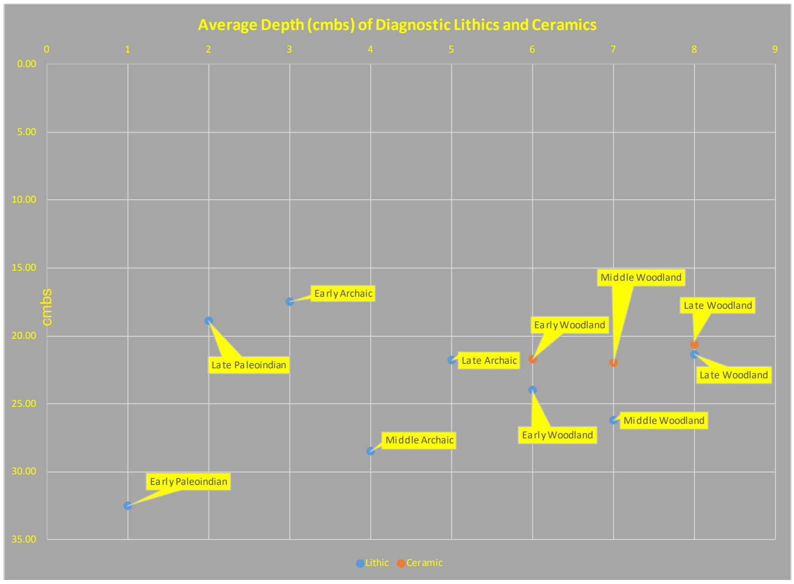


Figure 4.6. Average depth (cmbs) of diagnostic lithic and ceramic by typological classification for all site regions.

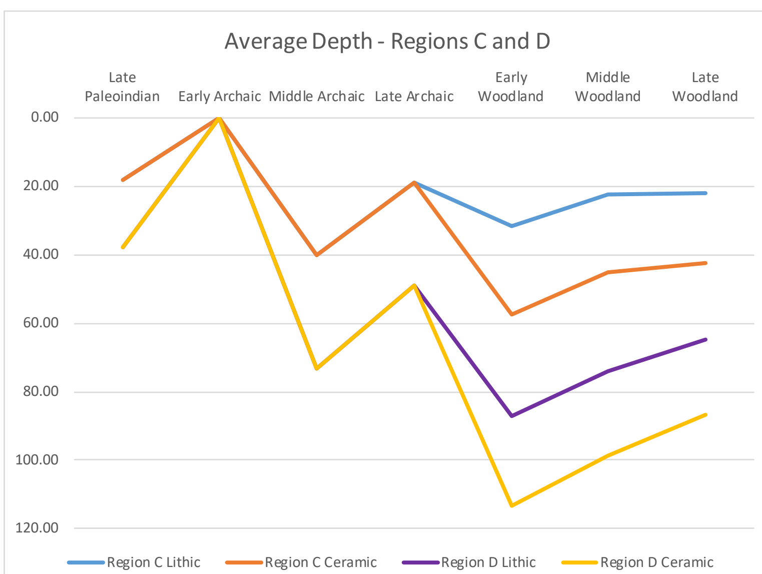


Figure 4.7. Average depth (cmbs) of diagnostic lithics and ceramics by typological classification for site regions C and D.

The first method, spatial data analysis, consisted of three techniques: descriptive statistics, nearest neighbor, and kernel density analysis (Burt et al. 2009). These three techniques provided a descriptive characterization of the point pattern associated with each cultural-temporal component and broadly characterized overall site use through time.

The second method, spatial statistical analysis, was applied to the data using local statistics of spatial autocorrelation (O'Sullivan and Unwin 2010). Spatial autocorrelation essentially measures the degree to which neighboring data values are similar (positive autocorrelation) or dissimilar (negative autocorrelation) (Cardinal 2011). In contrast to a global statistic that measures clustering or dispersion for the entire point pattern as a whole, local statistics measures clustering or dispersion for each individual location in the point pattern. The local statistic, Getis-Ord Gi*, enables detection of local concentrations of high or low values (hotspots or coldspots), identifying significant regions of density or scarcity within a given study area (Getis 2008, 2009; Getis and Ord 1992; Ord and Getis 2001).

Overall, the quantitative spatial analysis indicated an overall intensification of site use from the Middle Archaic through the Late Woodland components and that cultural temporal components could be segregated based on horizontal provenience (Haas 2017, 2018). The spatial analysis further confirmed the observation noted during the field excavations, that the earliest occupations were focused in the southern portion of the site with a gradual northward trend through time (Haas 2019). By site region, the Middle Archaic, Late Archaic, and Early Woodland components are concentrated in Region D with some activity in Region E. The Middle Woodland use of the site included Region C and D. During the Late Woodland, the most intensive activities were focused in site regions A and B. The maps displaying the results of the quantitative spatial analysis for the Early and Middle Woodland components, focusing on Regions C and D, are included as Appendix B.

Directed by the results of the quantitative spatial analysis, a more fine-grained investigation was subsequently conducted to further elucidate patterns of Early and Middle Woodland site use within Regions C and D (Haas 2019). Guided by the quantitative analysis, units and/or features were included within an activity area based on the following criteria: (1) the unit or feature falls within the activity area identified through the quantitative analysis; (2) the unit or feature produced a diagnostic; (3) the unit or feature does not overlay activity areas associated with earlier or later occupations; (4) the unit or feature is directly associated with (1) and/or (2) (Haas 2019). This process delineated discrete Early Woodland activity areas in Regions D and E (Figure 4.8; Table 4.2). Middle Woodland activity areas were defined in Regions C and D (Figure 4.9; Table 4.2).

AMS Dates

Four AMS dates have been secured for the Early and Middle Woodland occupations of the Finch site. Three are direct dates on residue adhering to ceramic vessels and the fourth is on charred annuals (Table 4.1 Haas 2019). The Finch dates indicate a later Early Woodland and Middle Woodland occupation, corresponding well with the archaeological data, as no thick wares were recovered from the site that would indicate an early Early Woodland occupation. The dates further concord with the chronology known for southeastern and southwestern Wisconsin. The data indicate both cultural and temporal overlap, not an unexpected occurrence given the current cultural-historical paradigm that posits the emergence of Middle Woodland from local Early Woodland antecedents. The temporal data further hint at possible underlying social complexities and dynamics, perhaps similar to southwestern Wisconsin, where Early Woodland Prairie phase ceramics co-occur with Middle Woodland Havana wares (Stoltman 1990, 2005, 2006). As well, the dates may result from pottery type definitions that are poorly dated and span lengthier intervals, and/or AMS dating of non-food residue, such as soot or wood smoke, post-dating the period of actual vessel use (Schiffer 1986).

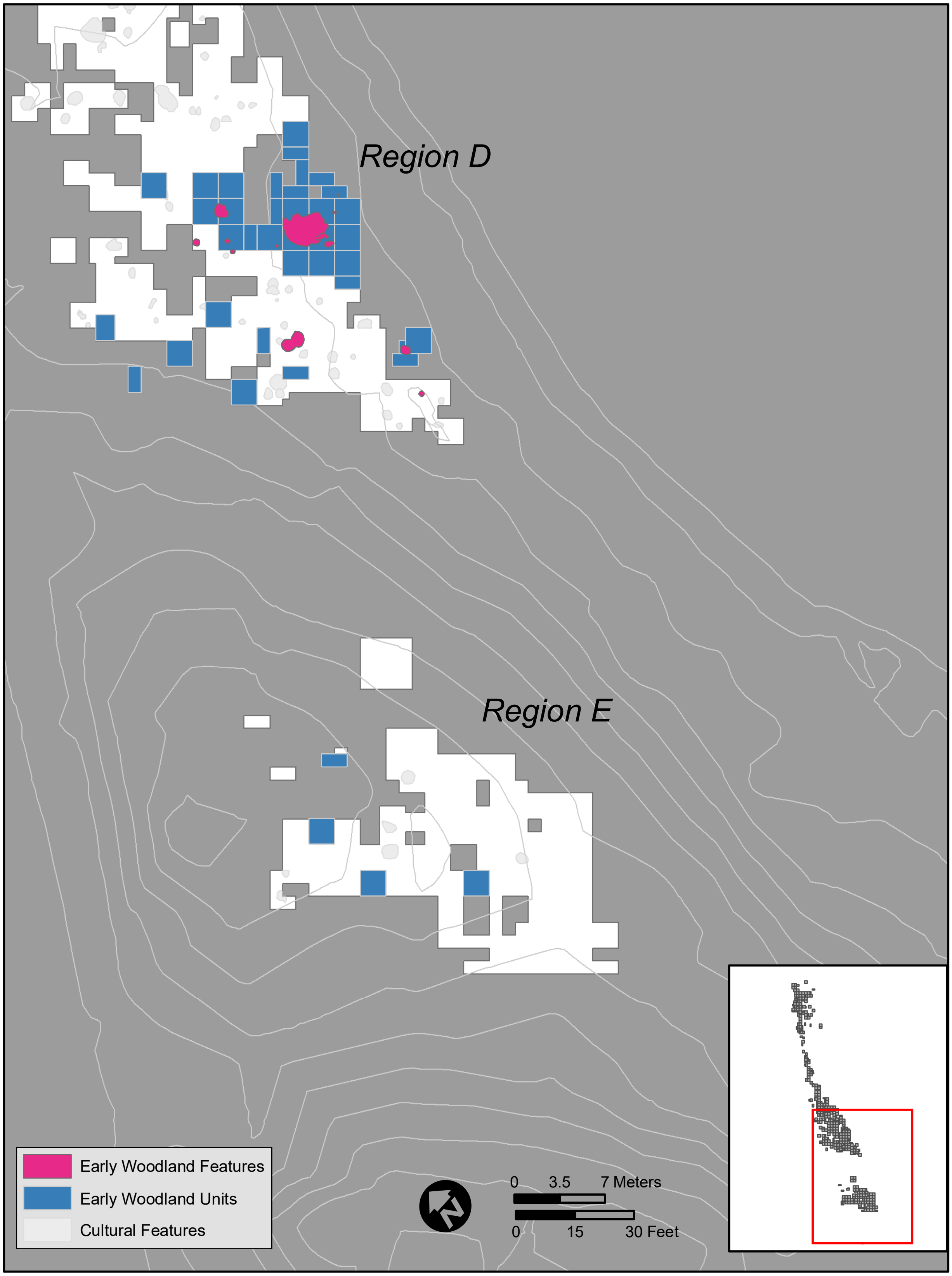


Figure 4.8. Activity areas associated with the Early Woodland component in Regions D and E.

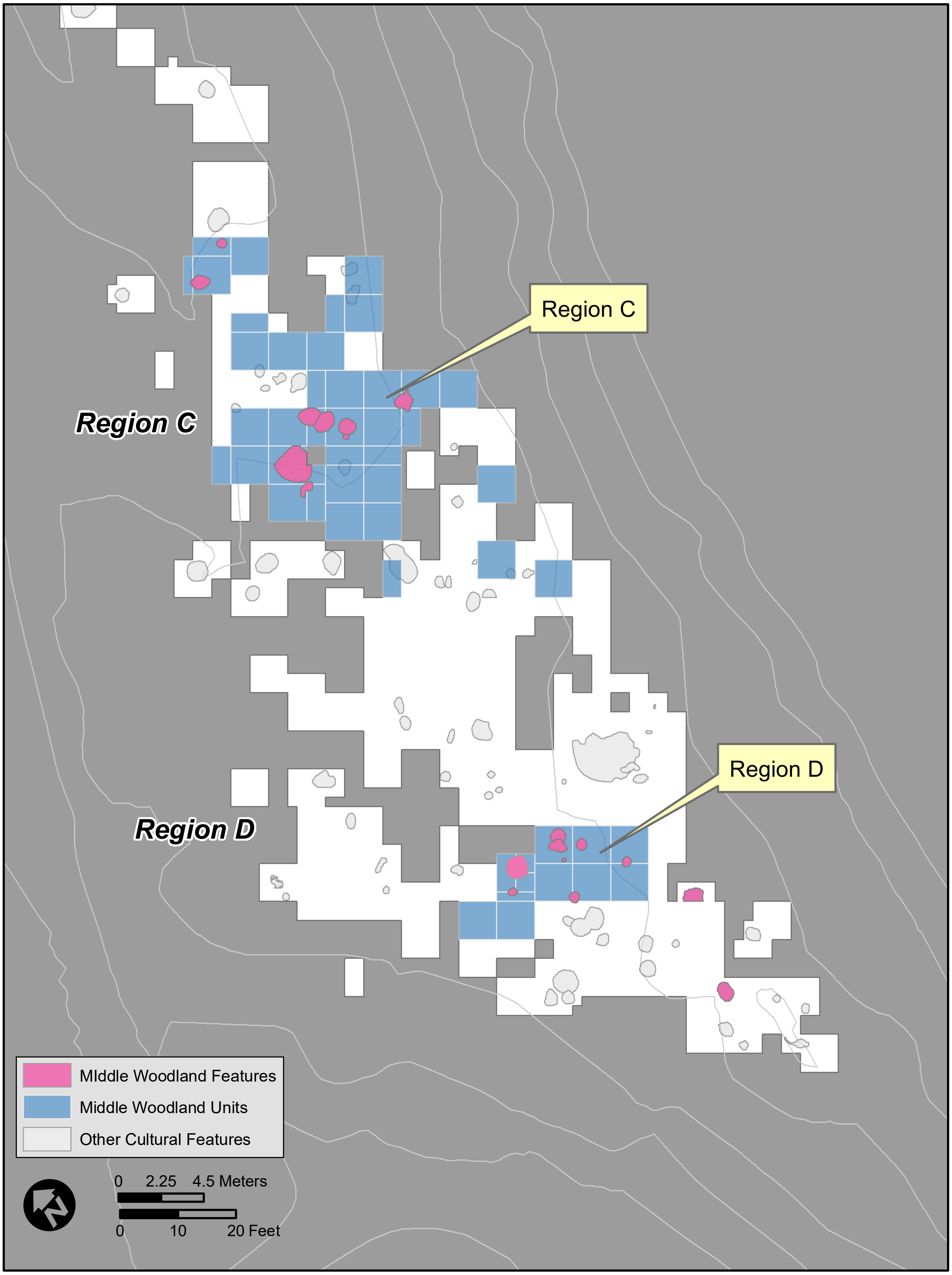


Figure 4.9. Activity areas associated with the Middle Woodland component in Regions C and D.

Table 4.1. AMS Dates for the Early and Middle Woodland Occupations at the Finch Site (47JE0902)

Lab No.	Description	14C age years BP	Calendar BC AD (2 Sigma Range)	Calibrated Median	Reference
UGAMS 28220	Dane Incised vessel residue (v.3010)	1930±25	AD 21 to 129	AD 72	Haas 2019
UGAMS 28221	Shorewood Cord Roughened vessel residue (v.2014)	2060±25	166 BC to AD 1	78 BC	Haas 2019
UGAMS 28222	Kegonsa Stamped vessel residue (v.2008)	1980±20	39 BC to AD 66	AD 24	Haas 2019
UGAMS 33333	Bitternut hickory in feature 114 with Shorewood Cord Roughened & Havana wares	1790±20	AD 178 to 325	AD 237	Haas 2019

Notes: Dates calibrated in CALIB 7.10 using IntCal13 calibration curve.

Table 4.2. Activity Areas Associated with the Early and Middle Components at the Finch Site (47JE0902)

Description	Total Number of Excavation Units	Total Area (m²)	Total Number of Features	Feature Types
Early Woodland				
Main Activity Area-Region D	40	127.50	19	Structure, Cooking Pits, Hearths Post Molds, Pits
Other Contexts-Region E	4	14.00	0	None
Total Early Woodland	44	141.45	19	
Middle Woodland				
North Activity Area-Region C	38	124	9	Structure, Cooking Pits, Hearths, Pits
South Activity Area-Region C/D	19	57.25	10	Cooking Pits, Hearths, Refuse Pits, Lithic Chipping/Refuse, Pit
Other Contexts-Regions A/B	0	0	2	Pits
Subtotal Middle Woodland	57	181.25	21	

Early Woodland Component

The Early Woodland activities at Finch are focused within the southern portion of the site in Regions D and and E (Figure 4.8). The primary activity area is situated within Region D consisting of a house basin and numerous cultural features, including several cooking pits. The area to the south of the Region D activity area is also associated with the Early Woodland component but is less intensively used and lacking cultural features

The Early Woodland material culture assemblage consists of grit-tempered pottery, chipped stone tools, fire-cracked rock (FCR), waste flakes, ground stone, faunal remains, and charred plant macroremains (Table 4.3). Relative frequencies, omitting the FCR, characterize the assemblage as having high quantities of waste flakes, grit-tempered pottery, chipped stone tools, and faunal remains with lower amounts of ground stone artifacts and plant macroremains (Figure 4.10). The chipped stone assemblage consists almost exclusively of local Galena chert, although few other local varieties and non-local materials are present in the assemblage. Diagnostic material culture associated with the Early Woodland components consists of Incised Over Cord Marked, Dane Punched, and Prairie ware vessels and hafted bifaces classified as Kramer and Waubesa stemmed (Table 4.4 Figure 4.11).

Region D Activity Area

An intensive Early Woodland activity area was identified in Region D consisting of a temporary structure (house) flanked by numerous cooking pits, multi-functional pits, an artifact scatter and a post mold (Figure 4.8; Figure 4.12). The Finch site assemblage thus far constitutes only the second Early Woodland domestic living space excavated in southeast Wisconsin (Benchley et al. 1997; Rusch 1988; Salzer n.d.).

The house structure (feature 25) is defined by a roughly oval to rectangular shallow house basin, encompassing 6.76 m^2, located in the northeastern portion of Region D, near the edge of the pond (Figure 4.8; Figure 4.12; Figure 4.13). The few artifacts recovered from the house feature include

Table 4.3. Early Woodland Material Culture Assemblage

Description	Count	Percent Count	Weight (g)	Percent Weight
Ceramic	3465	14.92	17869.29	10.03
Chipped Stone Tool	500	2.15	3774.64	2.12
Waste Flakes	14866	64.00	14602.83	8.20
Ground Stone	10	0.04	2918.66	1.64
Faunal	4083	17.58	451.88	0.25
Plant Macroremains	305	1.31	6.03	0.00
FCR	--	--	138466.23	77.75
Total	23229	100.00	178089.56	100.00

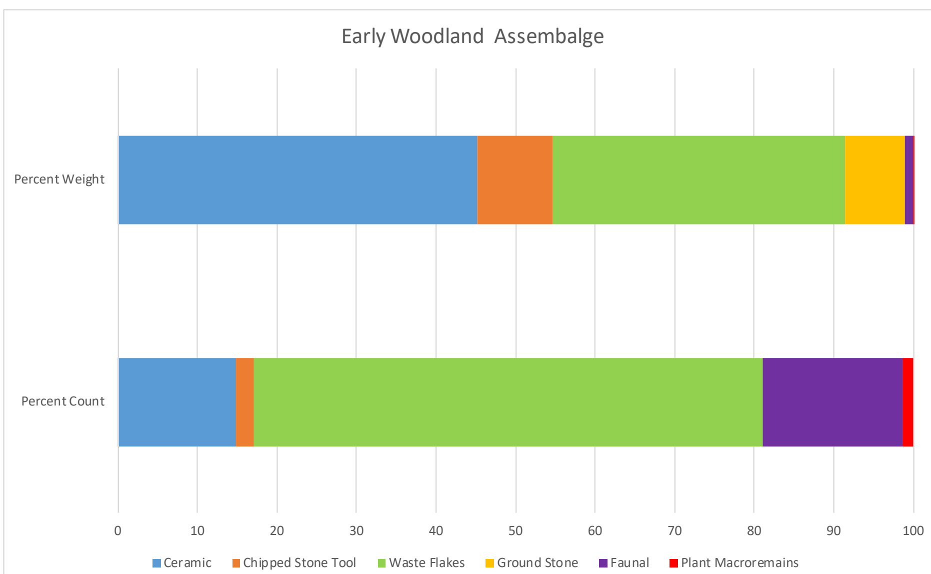


Figure 4.10. Relative frequency of the Early Woodland material culture assemblage, omitting the FCR.

Table 4.4. Early Woodland Diagnostic Material Culture

Description - Typological Classification		Count
Ceramic Vessels		
	Incised over Cord Marked	22
	Dane Punched	1
	Prairie Ware	4
Chipped Stone Tool		
	Kramer	14
	Waubesa	50
	Kramer/Waubesa	4
	Unclassified Stemmed	2

Figure 4.11. Sample of Diagnostic Early Woodland material culture: Kramer hafted bifaces (top left), Waubesa hafted bifaces (top right), IOCM vessels (bottom).

grit-tempered pottery body sherds (non-diagnostic), retouched/utilized flakes, waste flakes, and faunal remains. Faunal remains are identified as fish and most specimens were burned. The chipped stone assemblage is largely composed of local Galena chert, although a few Silurian chert and Burlington chert forms are present. Although diagnostics were not present within the feature fill, three Incised over Cord Marked vessels were recovered from adjacent units.

Material culture from the units surrounding feature 25 supports the interpretation of the feature as a domestic structure. These units produced a high density of grit-tempered pottery, with notable concentrations located along the northern and western margins. A pottery cluster (feature 63) was

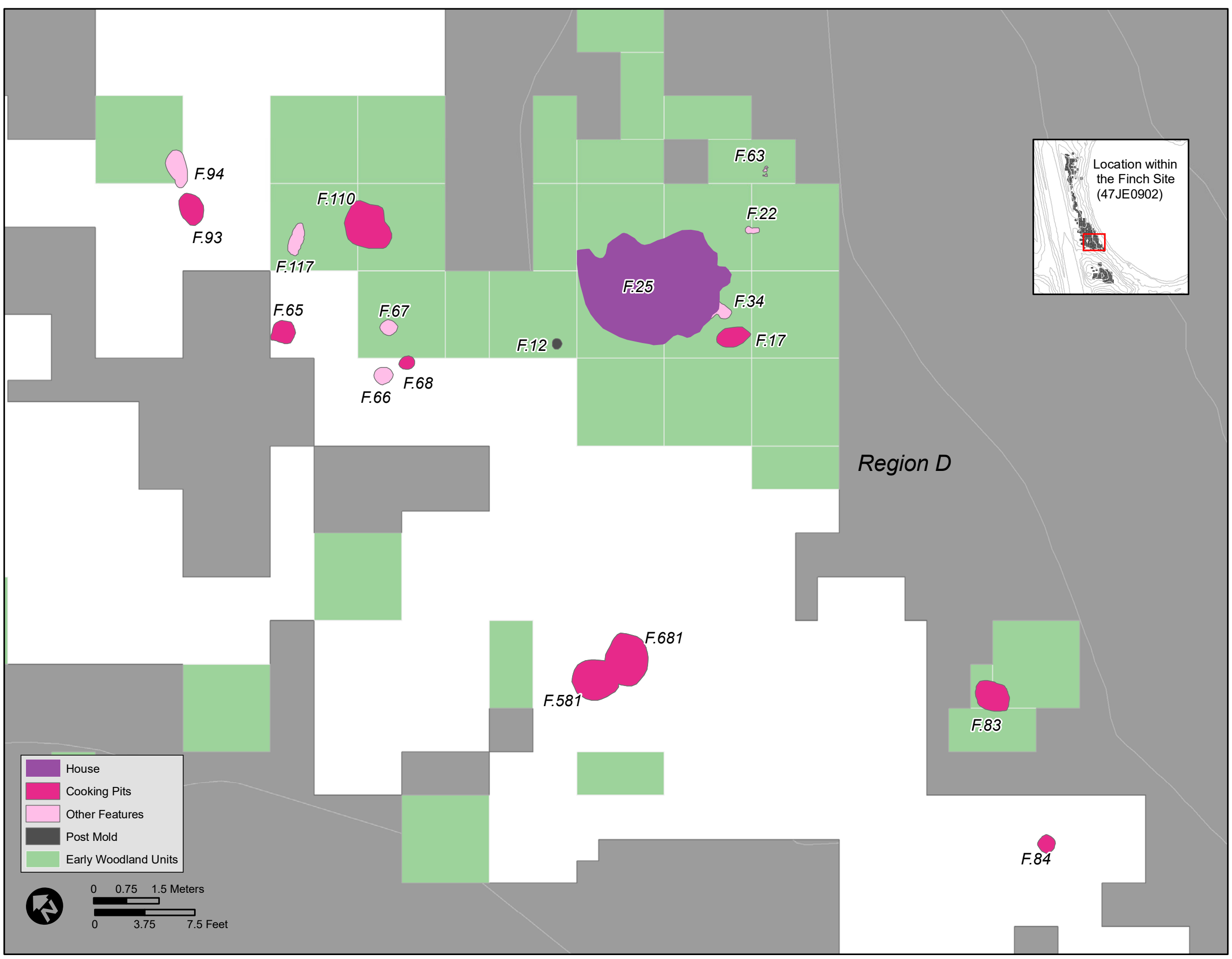


Figure 4.12. Early Woodland activity area in Region D.

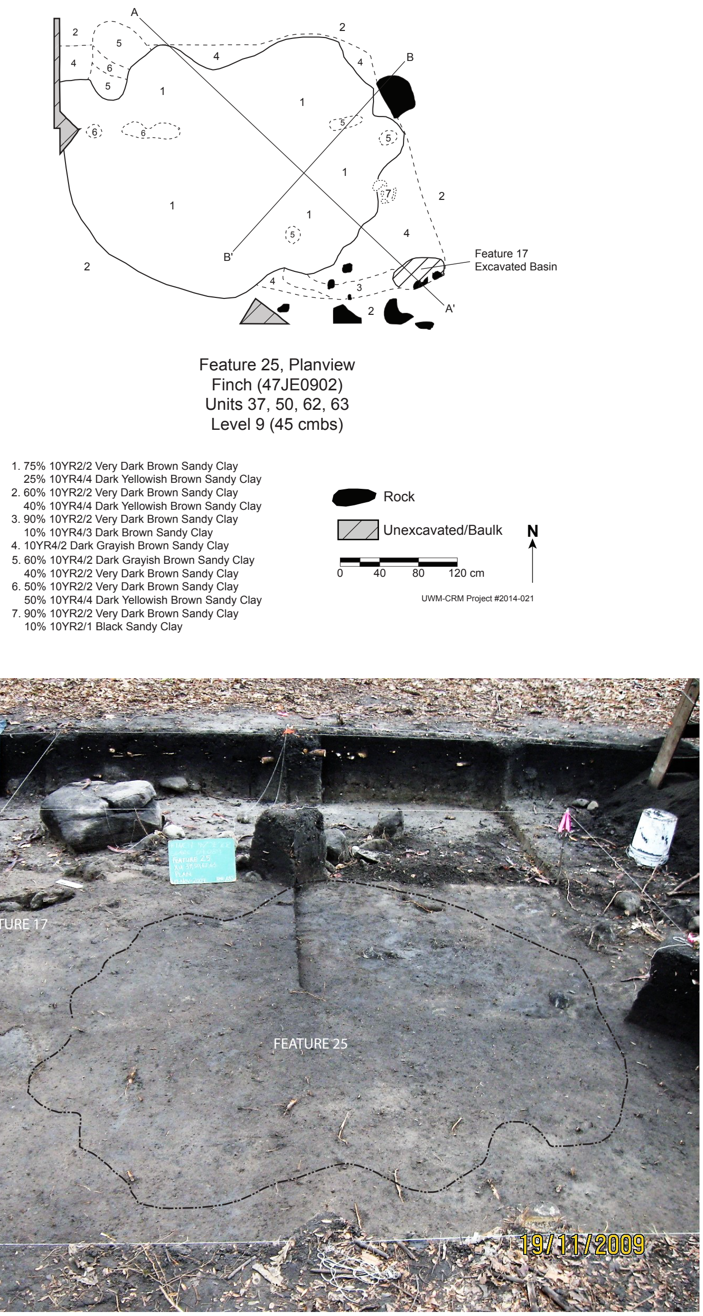


Figure 4.13. Planview (top) and photograph (bottom) of feature 25 and feature 17, view to the south.

identified to the northeast of the structure. Just to the southwest of feature 25 are high densities of faunal remains, largely composed of burned medium/large mammal remains. Also associated with feature 25 is a shallow sandstone bowl exhibiting heavy erosion along the rim indicating use as a container (Figure 4.14). The units surrounding feature 25 yielded low densities of chipped stone tools, waste flakes, and fire-cracked rock, supporting the interpretation of an area for domestic activities rather than an intensive processing area.

Associated with the house basin are a post mold (feature 12), a cooking pit/hearth (feature 17), pits of an indeterminate function (features 22 and 34), and a cluster of grit-tempered pottery (non-diagnostic) (feature 63). The cooking pit/hearth (feature 17) contained burned medium sized mammal bone. The post mold is located just under one meter to the southwest of the feature 25 basin, likely representing an exterior support post. Other posts may have supported the structure, but no evidence of additional posts were identified during the site excavations. Given the site's soil stratigraphy, consisting of a dark and deep sandy loam A-horizon, posts may not have been easily distinguishable from the non-feature matrix during field excavation.

Figure 4.14. Sandstone bowl associated (lot 09.089-0313) with the Early Woodland structure (feature 25).

Surrounding the feature 25 house basin, to the south and west, are a total of eight cooking pits, including feature 17 noted above, and four pits of an indeterminate function. Cooking pits are identified as such based on the occurrence and patterning of FCR, an organic or enriched feature fill composition, as well as the presence and abundance of faunal remains and plant food macroremains (Figure 4.15; Figure 4.16). All of the Early Woodland cooking pits are circular to oval shaped in planview, and basin shaped in profile, with overall depths ranging between 15 to 40 cm. The Early Woodland cooking pits yielded grit tempered pottery, chipped stone tools (all non-diagnostic), waste flakes, ground stone, faunal remains, and plant macroremains. The feature assemblage is characterized by high quantities of faunal remains and waste flakes, moderate amounts of grit-tempered pottery, and low representation of chipped stone tools and ground stone. The grit-tempered pottery from cooking pits include five Early Woodland vessels recovered from four features (features 65, 83, 110, and 581). Plant foods are represented by nutshell (walnut family, black walnut, and acorn), squash rind, and a single wild seed. Identified animal taxa includes fish (all unidentified), white-tailed deer (*Odocoileus virginianus*), wolf/coyote/dog (Canis), turtle (Testudines), unidentified mammal remains, and specimens unidentifiable to species. Two white-tailed deer fragments within Feature 581, both representing the lower leg and foot, exhibit cut marks. Much of the faunal material present in the cooking pits was burned.

The composition and density of material culture from unit contexts provides further clues to site activities occurring within Region D during the Early Woodland. The cooking pits and other features occur in two groups within Region D, a more northern group situated to the west of the structure (feature 25) and a southern group composed of four cooking pits (feature 83, 84, 581, and 681) (Figure 4.12). The southern portion of Region D yielded very high densities of chipped stone tools, waste flakes, and fire-cracked rock, suggesting an intensive processing area. Two of the cooking pits in this area yielded butchery evidence in form of cut marks on the lower leg portions of white-tailed deer. The southern margin of the Region D activity area may also reflect the edge of midden or disposal area. Notably, the units surrounding feature 83, in the far southwestern portion of the region, produced a high density of pottery, indicating cooking related tasks.

Figure 4.15. Feature 83: an Early Woodland cooking pit in Region D

Figure 4.16. Features 581 and 681: Early Woodland cooking pits in Region D, note FCR at the base of the pit.

The northern group includes the house (feature 25) and related features, as well as three cooking pits (features 65, 93, and 110) and pits of an indeterminate function (66, 67, 94, and 117). Material culture from unit contexts surrounding these features yielded high densities of grit-tempered pottery suggesting cooking and/or serving related tasks. The units surrounding feature 110 produced very high densities of waste flakes, fire-cracked rock, and faunal remains, possibly representing the cleaning out of the feature prior to re-use.

Middle Woodland Component

The Middle Woodland component consists of cultural features and several activity areas, located throughout the site in Regions A, B, C and D, with notable concentrations situated to the north and south of the Early Woodland occupation in Regions C and D (Figure 4.9).The Middle Woodland material culture assemblage consists of grit-tempered pottery, chipped stone tools, fire-cracked rock (FCR), waste flakes, ground stone, faunal remains, and charred plant macroremains (Table 4.5). Relative frequencies, omitting the FCR, characterize the assemblage as having high quantities of waste flakes, grit-tempered pottery, chipped stone tools, and faunal remains with lower amounts of ground stone artifacts and plant macroremains (Table 4.6; Figure 4.17). The chipped stone assemblage consists almost exclusively of local Galena chert, although a few other local varieties and non-local materials are present in the assemblage. Diagnostic material culture associated with the Middle Woodland components consists of several vessel types as well as Snyders and Steuben hafted bifaces (Table 4.6; Figure 4.18). Vessels types include Havana ware, Naples Stamped, Sister Creeks Punctate, Kegonsa Stamped, Shorewood Cord Roughened, and Hopewell related. A neckless jar form and transitional wares, Deer Creek Incised and Douglass Net Marked, are included in the Middle Woodland vessel assemblage.

The primary Middle Woodland activities at the Finch site consist of two intensive activity areas in Regions C and D (Table 4.6). Two other isolated areas of Middle Woodland activities are present in the northern site area, within Regions A and B, in a portion of the site that was subsequently

Table 4.5. Middle Woodland Material Culture Assemblage

Description	Count	Percent Count	Weight	Percent Weight
Ceramics	2592	11.73	24847.85	14.24
Chipped Stone Tool	434	1.96	2921.23	1.67
Waste Flake	14714	66.59	16285.36	9.33
Ground Stone	4	0.02	3022.77	1.73
Mineral/Red Ochre	0	0.00	0.66	0.00
Faunal	4200	19.01	744.86	0.43
Plant Macroremains	153	0.69	31.58	0.02
FCR		0.00	126695.49	72.58
Total	22097	100.00	174549.80	100.00

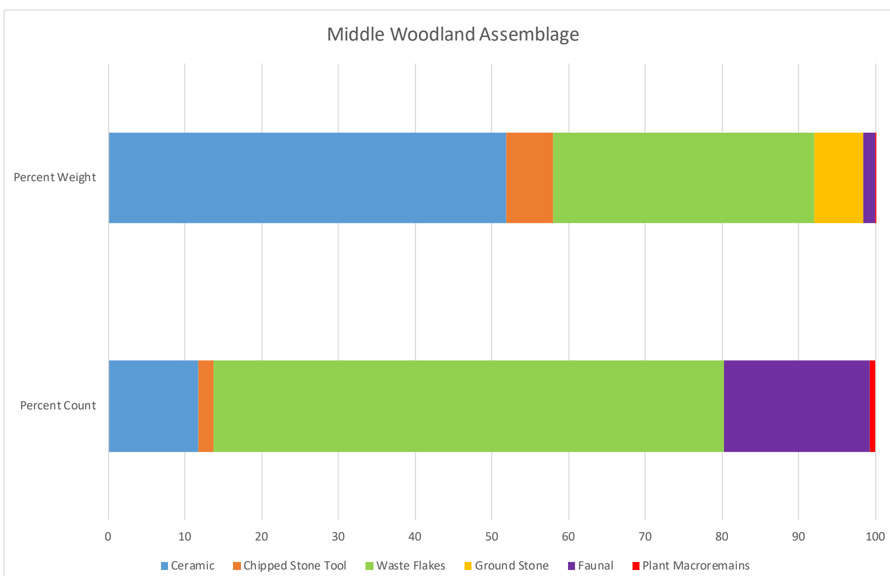


Figure 4.17. Relative frequency of the Middle Woodland material culture assemblage, omitting the FCR.

Table 4.6. Middle Woodland Diagnostic Material Culture

Description - Typological Classification		Count
Ceramic Vessels		
	Deer Creek Incised	1
	Havana ware	4
	Hopewell related	1
	Kegonsa Stamped	12
	Shorewood Cord-Roughened	21
	Naples Stamped	3
	Sister Creeks Punctate	1
	Neckless (Tecomate) Jar	1
	Douglass Net Marked	1
Chipped Stone Tool		
	Snyders	11
	Steuben	18

Figure 4.18. Sample of diagnostic Middle Woodland material culture: Snyders hafted bifaces (top left), Steuben hafted bifaces (top right), Shorewood Cord Roughened vessel (bottom left), Havana Zoned vessel (bottom right).

heavily used by Late Woodland occupants. Activities in Regions A and B are represented by two features: a single cleaned out hearth (Feature 146) and an artifact scatter (Feature 112) consisting of a nearly complete Shorewood Cord Roughened vessel. As site regions A and B define an area of intensive Late Woodland activities, this dissertation project largely focuses on the Middle Woodland material culture and data from Regions C and D. The activity areas in Regions C and D are described in more detail below.

Region C Activity Area

An intensive Middle Woodland activity area was identified in Region C, consisting of a temporary structure (house) flanked by cooking pits, multi-functional pits, and an artifacts scatter (Figure 4.19). The Finch site assemblage constitutes the first Middle Woodland domestic living space excavated in southeast Wisconsin (Benchley et al. 1997; Salzer n.d.).

The house structure (feature 96) is defined by a roughly circular shallow house basin, encompassing 2.6 m^2, located in the southwestern portion of Region C (Figure 4.20; Figure 4.21). The few artifacts recovered from the house feature include grit-tempered pottery, waste flakes, burned animal bone (unidentifiable), plant macroremains (squash rind, hickory nutshell, and bedstraw), and fire-cracked rock. The grit tempered pottery reflects a minimum of two vessels, identified as Havana ware (vessel 2001) and Sister Creeks Punctate (vessel 2006). The presence of squash rind within a domestic context, and its absence from cooking pits, suggests its use for serving activities.

Surrounding the feature 96 house basin, to the northeast, east, and southeast, are six pit features including two cooking pits (features 47 and 48) and four multi-functional pits (features 37, 41, 97, and 121) (Figure 4.19). North of the house basin and pit feature cluster are two features, an artifact scatter (feature 113) and a pit feature of an indeterminate function (feature 88). The artifact scatter consists of a nearly complete ceramic vessel (vessel 2003) typologically classified as Shorewood Cord Roughened.

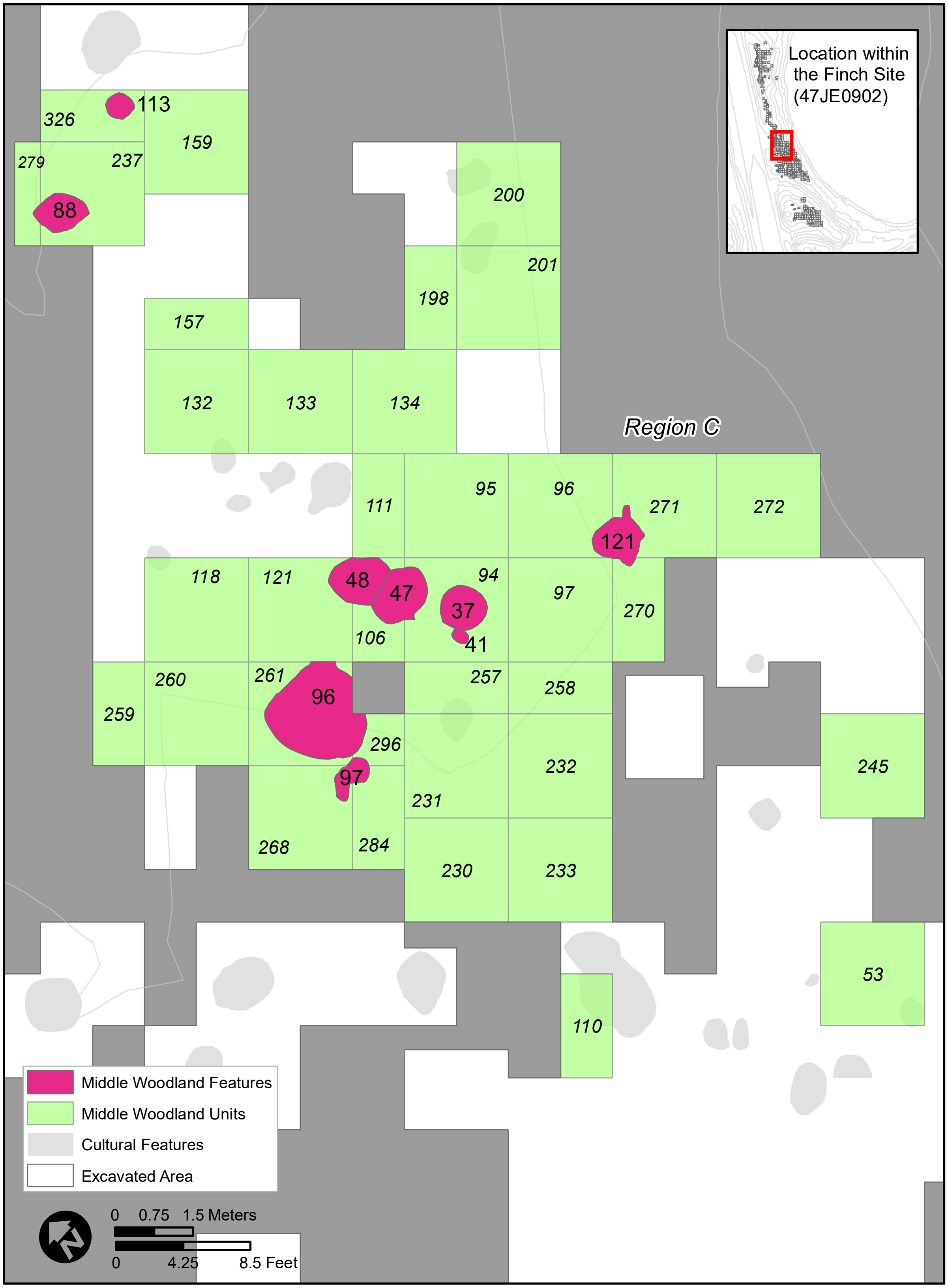


Figure 4.19. Middle Woodland activity area in Region C.

Figure 4.20. Planview (photograph) of feature 96, view to northeast.

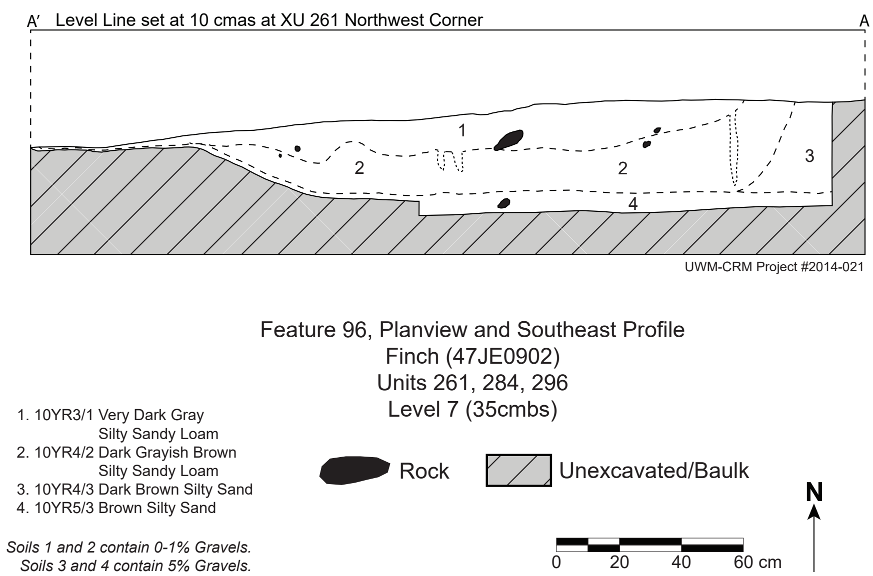


Figure 4.21. Southeast profile of feature 96.

The cooking pits are identified as such based on the occurrence and patterning of FCR, an organic or enriched feature fill composition, as well as the presence and abundance of faunal remains and plant food macroremains. The two cooking pits near the house are oval to circular in planview, basin shaped in profile, with depths ranging from 13 to 18 cm. The cooking pits yielded grit tempered pottery, flake tools, waste flakes, burned animal bone (unidentifiable), wood charcoal, nutshell (hickory and acorn), and fire-cracked rock. Both cooking features exhibited distinct clustering of FCR within the feature matrix; Feature 47 is notable for its high quantity of fire-cracked rock (Figure 4.22).

The feature data, as well as the composition and density of material culture from unit context provides further clues to site activities occurring within Region C during the Middle Woodland. Overall, the Region C artifact assemblage is characterized by high quantities of grit-tempered ceramics and plant macroremains, moderate amounts of waste flakes, and low amounts of animal

Figure 4.22. Planview (view to the east) of a cooking pit (Feature 47) near the Middle Woodland house in Region C. Note the clustering of FCR.

bone and chipped stone tools. The high density of pottery recovered from the region suggests that domestic tasks, including cooking, occurred within and near to the structure. All units and features within Region C yielded grit-tempered pottery and a total of 17 vessels are represented in the assemblage. Some of the vessels represent nearly complete pot, such as the Shorewood Cord Roughened vessel (vessel 2003) that defines feature 113 (Figure 4.23). Distinct concentrations of pottery cluster in and around the structure as well as by the cooking pits (features 47 and 48), underscoring their use in cooking tasks.

Based on feature data, cooking tasks within Region C involved the processing of nuts and, to a lesser extent, animal remains. All of the features in Region C yielded charred nutshell, including hickory, hazelnut, and acorn. In addition, four features yielded squash rind, suggesting the processing of squash and/or use of the plant for cooking and/or serving tasks. Animal bone was recovered from four of the features in Region C. All of the animal bone from features was burned, fragmented, and not identifiable to species.

Figure 4.23. Photograph of vessel 2003 (Shorewood Cord Roughened), showing a portion of the nearly complete vessel recovered near the Middle Woodland house.

The fire-cracked rock from Region C is associated with cooking-related tasks. All of the cooking pits exhibited evidence of distinct FCR clustering, especially evident in feature 47, which appears as rock-filled type hearth (Figure 4.22). FCR was recovered from most units within the region, with a notable concentration from the unit to the southeast of the structure and northeast of a pit feature (feature 97). The patterning of FCR in and around feature 97 suggests that the feature may have functioned for cooking tasks, representative of several periods of use, with FCR cleaned out from the feature following cooking events.

Region C was not a focus of intensive animal resource processing. Overall, the faunal density within the region is extremely light, with only 46 fragments represented, most of which are unidentifiable. Five features (feature 37, 47, 48, 96, and 121) produced animal bone; these specimens are all burned but not identifiable to taxon or species. A few animal bone fragments from unit contexts were identified as mammal (including muskrat), bird, and reptile (turtle). The mammal bone manifests equal representation of the small, medium, and medium/large classes. None of the faunal material, from unit or feature contexts, exhibited evidence for butchery. There is no evidence for the extensive processing of animals, especially large mammals, in the Middle Woodland Region C activity area. The overall low density of faunal remains is suggestive of a domestic base camp where bone waste disposal occurs away from the living area (Binford 1978; Gifford-Gonzalez 1989).

The density and patterning of chipped and ground stone tools supports the assessment of the Region C area as oriented towards domestic cooking tasks as contrasted with heavy resource processing. Tool density is moderate for the region; however, chipped stone tools were not recovered in and around the structure. Chipped stone tools are concentrated in the units surrounding pit features 37 and 41 and in the far southeastern portion of the region, unassociated with any features. The few ground stone artifacts recovered from Region C are associated with a cooking pit and a mutli-functional pit. Use wear on the ground stone artifacts indicate use for pounding on a flat surface and for abrading/spinning.

Of note from Region C is the recovery of several seeds from a pit feature (feature 37), of an indeterminate function, that have been identified as tobacco (Haas 2019). Tobacco has been identified from Middle Woodland contexts in the Illinois River valley where it has been dated to circa 70 BC to AD 320 (Asch and Asch 1985). At the Bachman site in eastern Wisconsin, two tobacco seeds may be associated with the late Early Woodland component, although derived from a mixed context (Rusch 1988).

Region D

An intensive Middle Woodland activity area, focused on animal resource processing, is identified in Region D that is composed of seven cooking pits/hearths and three multi-functional pits (Figure 4.24). Most Middle Woodland features in Region C occur in close proximity to one another and are present in excavation units that are exclusively related to the Middle Woodland component based on the site structure analysis (Haas 2017, 2018). Three additional features (features 82, 84, and 129) are associated with the Middle Woodland component but are situated to the southeast of the main cluster of Middle Woodland features and units in Region D (Figure 4.24). Overall, the Middle Woodland activity area in Region D is characterized by high quantities of waste flakes, faunal remains, grit-tempered pottery, and fire-cracked rocks, with moderate to low amounts of chipped stone tools and plant macroremains, and ground stone.

The intensive animal processing activities are indicated by the number, type, and content of the cooking pits as well as the high tool density. Over four hundred chipped stone tools, including formal tools, flake tools (retouched and utilized flakes), and cores/core tools were recovered from the Region D activity area. The tool density average eight tools per square meter excavated, far greater than the tool density in the Middle Woodland activity area in Region C, which averaged just one tool per square meter excavated. Within Region D, most tools are manufactured from local Galena chert, although a few specimens of non-local Burlington chert and Wyandotte chert are represented in the tool assemblage. The Region D tools are characterized by high frequencies

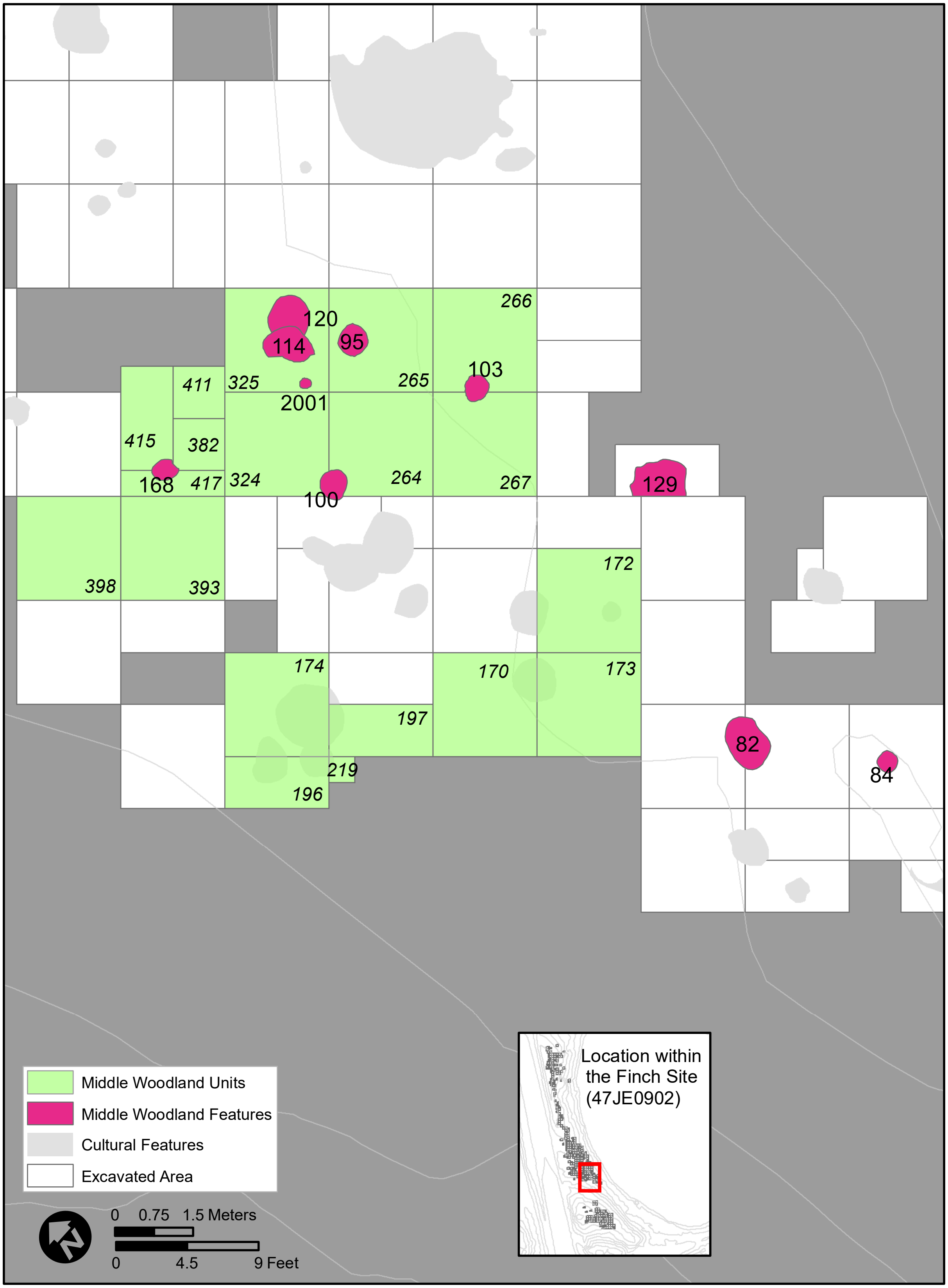


Figure 4.24. Middle Woodland activity area in Region D.

of flake tools, as over one-half of the chipped stone tools define utilized or retouched flakes. Such high frequencies of flake tools is indicative of expedient use of stone for various types of resource processing tasks. Evidence also suggests that tool manufacture occurred within Region D. Feature 168, a cleaned out cooking pit later used for refuse, yielded an exceedingly high density of waste flakes, likely from a single knapping episode.

The seven Middle Woodland cooking pits in Region D are oval to circular in planview, and basin shaped in profile, with maximum depths ranging from 22 to 45 cm. These cooking pits yielded fire-cracked rock, grit tempered pottery, chipped stone tools, waste flakes, ground stone, faunal remains, and plant macroremains. The assemblage is characterized by high quantities of faunal remains and waste flakes, moderate amounts of grit-tempered pottery, and low representation of chipped stone tools and ground stone. Diagnostic artifacts from the cooking pits include both pottery and hafted bifaces. Nine Middle Woodland vessels were recovered from three of the cooking pits (features 95, 114, and 129) and Feature 82 yielded a Steuben point. Charred plant food macroremains from the cooking pits consists of nutshell identified as walnut family, hickory, bitternut hickory, hazelnut, and acorn. One feature, feature 168, produced a few nut meats. Animal taxa represented in the cooking pits consist of fish (channel catfish and unidentifiable varieties), even-toed ungulate, white-tailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*), turtle (Testudines), mammal remains (mostly medium/large and large), and specimens unidentifiable to species. Cut marks are present on several white-tailed deer fragments, including portions of the foot bone, and other large mammal fragments, all recovered from Feature 129. Nearly all of the faunal material present in the cooking pits was burned.

The form and content of the seven cooking pits in the Middle Woodland Region D activity area indicates that two types of cooking pits are represented by the archaeological data. One type contains unidentifiable fragments of burned animal and nutshell or nutmeat fragments (features 100 and 168). The second type is characterized by high quantities of medium/large mammal bone (especially white-tailed deer), bird, fish, and/or turtle remains (features 82, 95, 114, 129, and 167). Some of these pits are further associated with nutshell fragments. The cooking pits identified in Middle Woodland activity area Region C conform with the first type.

The processing activities in Region D were heavily oriented toward the processing of medium/large mammals, emphasizing white-tailed deer. All of the cooking pits in Region D yielded faunal remains and most yielded medium/large mammals. Faunal remains were also recovered from every Middle Woodland unit in Region D. Medium/large mammals are well represented in the cooking pit assemblage as well as composing nearly all (98 percent) of the identified faunal material from unit contexts. Other mammals (including raccoon), as well as fish, turtle, and bird are represented in the region but are less abundant. Several cooking pits produced small amounts of nutshell and nutmeats suggesting that they were a minor component of the cooking tasks. The patterning of FCR from both within and surrounding features indicates that many of the cooking pits may have been habitually cleaned out and re-used either for another cooking episode or for a different function (such as refuse).

A worked bone specimen, a drilled raccoon canine, was recovered from one of the cooking pits in Region D (feature 95) (Figure 4.25). This specimen was modified into a pendant/ornament by drilling a hole in the root of the tooth and exhibits polish and cut marks (Stencil 2015). The pendant/ornament is similar to a *Canis* canine ornament/pendant from Middle Woodland contexts at the Highsmith site (Salzer 1965). Likely unrelated to utilitarian processing/cooking activities, the raccoon pendant/ornament represents an emblematic Waukesha phase artifact type (McKern 1942; Salzer n.d., 1965).

In sum, the Middle Woodland component at the Finch site consists of two loci of activities. The archaeological data indicate that different types of activities occurred in Region C and compared to Region D. The more northern activity area in Region C defines a living space where domestic tasks, including cooking, occurred within and near to a house. The more southerly area, in Region D, delineates a space where intensive animal resource processing took place. Cooking pits are associated with both loci and represent at least two distinct types.

Interaction

The Finch site, as a domestic habitation, yielded evidence of a connection with the Havana-Hopewellian world through pottery forms, lithic styles, raw materials, and technologies, as well as emblematic artifacts. The Middle Woodland occupation of the Finch site falls within the accepted date range for Havana-Hopewell.

The Finch site ceramic assemblage exhibits much influence of Havana-Hopewell, namely the occurrence of local Rock ware types, Kegonsa Stamped and Shorewood Cord Roughened, as well as several Havana ware forms. The Kegonsa Stamped and Shorewood CordRoughened vessels are

Figure 4.25. Drilled raccoon canine from a Middle Woodland cooking pit (feature 95).

decorated within a variety of forms, including incising, cord-wrapped stick impressions, nodes/ boosses, punctates, stamping, and trailing, that are interpreted as a southern influence (Salzer n.d.). The presence of non-local Havana wares, including Havana Plain, Havana Zoned, Naples Stamped, and Sister Creeks Puncate further speak to this influence. Moreover, two unique vessels associated with the Middle Woodland component provide further evidence for southern Hopewellian influences, a Hopewell related vessel and a neckless jar.

The Hopewell-related vessel (v.3034) shows external influence withs its fine execution of incised curvilinear lines. Rather than the limestone temper of classic Hopewell ware, this vessel is tempered with grit, exhibiting a paste similar to other local Middle Woodland forms.

The neckless jar (v.2025) resembles a seed jar or bowl typical of Hopewell ware, however, the vessels is tempered with grit. The appearance of the bowl form during the Middle Woodland is known for the Illinois River Valley as well as in the American Bottom (Fortier 2001).

Lithic technologies associated with the Middle Woodland component indicate inter-regional connections with the Hopewellian world. Specifically, the recovery of Snyders projectiles points, evidence for blade technologies, and non-local materials indicate influences from the south (Figure 4.26; Figure 4.27). Diagnostic projectile points/knives associated with the Middle Woodland component include Snyders and Steuben forms. Both Snyders and Steuben points are diagnostic of the Middle Woodland Havana-Hopewell tradition. Both exhibit triangular to ovate blade forms with corner notches and expanding stems (Morrow 2015).

In addition to the diagnostic projectile points/knives, a total of three blade cores were recovered from the Finch site that are associated with the Middle Woodland component (Figure 4.27). The blade cores are manufactured from Galena chert, Burlington chert, and unidentified cherts. Blade cores produce elgonated flakes, or blades, that are sequentially removed from the core. These elongated flakes are small, regularly shaped artifacts with sharp cutting edges (Montet-White 1968). Blade core technology is characteristic of Middle Woodland industries in the central

Figure 4.26. Hoe manufactured of Burlington chert likely associated with the Middle Woodland component.

Figure 4.27. Blade core of Burlington chert associated with the Middle Woodland component.

and lower Illinois River valley where they constitute over sixty percent of the chipped stone assemblage (Montet-White 1968:28). Small prismatic blades are recognzied as a key component of Hopewellian industries (Montet-White 1968).

The raw materials of the diagnostic projectile points/knives, as well as the diagnostic stone tools and waste flakes, indicate a nearly exclusive reliance on locally available cherts, especially Galena chert, by the Middle Woodland site occupants. However, some chipped stone tools are manufactured from non-local materials that have source areas outside the region including Burlington chert, and Wyandotte chert. Of the sixty chipped stone tools manufactured from non-local materials, all but three are of Burlington chert. The other materials are Wyandotte chert and Cochrane chert.

In addition to the ceramic and lithic artifacts, emblematic Hopewellian artifacts are associated with the Middle Woodland component at the Finch site. A worked bone specimen, a drilled raccoon canine, was recovered from one of the cooking pits in Region D (feature 95). This specimen is modified into a pendant/ornament by drilling a hole in the root of the tooth and exhibits polish and cut marks (Stencil 2015). The pendant/ornament is similar to a Canis. canine ornament/pendant from Middle Woodland contexts at the Highsmith site (Salzer 1965). Likely unrelated to utilitarian processing/cooking activities, the raccoon pendant/ornament represents an emblematic Waukesha phase artifact type (McKern 1942; Salzer n.d., 1965).

Finally, the recovery of probable tobacco seeds from a pit feature (feature 37) suggests a connection to Hopewell. The presence of tobacco in a Middle Woodland domestic context is particularly intriguing. The Middle Woodland stage marks the first reported appearance of pipes from archaeological sites in Wisconsin (Sabo 2007; Stevenson et al. 1997). Curved and straight based platform type pipes are associated with Waukesha phase mortuary contexts in southeastern Wisconsin but are generally not recovered in domestic contexts (Salzer n.d.). However, at the Alberts site, surface collection of the fields east of the mounds yielded a fragment of a Hopewellian monitor pipe manufactured of Illinois pipestone (Jeske and Kaufman 2000). At the Finch site, a pit feature yielded several seeds from a that have been provisionally identified as tobacco. Tobacco has been identified from Middle Woodland contexts in the Illinois River valley where it has been dated to circa 70 BC to AD 320 (Asch and Asch 1985). In Wisconsin, at the Bachmann site in eastern Wisconsin, two tobacco seeds may be associated with the late Early Woodland component, although derived from a mixed context (Rusch 1988).

Evidence for interaction with extra-regional groups is accomplished through a comparison of non-local lithic raw materials associated with the Early and Middle Woodland components. In general, both the Early and Middle Woodland lithic assemblages are characterized by high frequencies of local materials and very low frequencies of non-local materials (Table 4.7; Appendix C). The local raw material is nearly exclusively Galena chert. Galena chert is sourced in south-central and south-western Wisconsin, northwestern Illinois, southeastern Minnesota, and northeastern Iowa but also outcrops in central Rock and Jefferson counties in southeastern Wisconsin (Bakken 1997; Morrow and Behm 1985; Morrow 1994; Winkler et al. n.d.). The Early and Middle Woodland waste flake assemblages have nearly identical relative frequencies of local and non-local raw material types (Table 4.7).

The composition of the Early and Middle Woodland non-local lithic waste flake assemblage are strikingly similar (Table 4.7;Appendix C) . For both components, the most abundant non-local lithic types are Burlington chert, orthoquartzite, and Wyandotte chert indicating source areas in southwest Wisconsin, southeast Iowa, west-central Illinois, and Indiana (Table 4.8). The Early Woodland waste flake assemblage includes eight non-local material types. Represented in the Middle Woodland waste flake assemblage are seven non-local varieties, the same types within the Early Woodland assemblage except for Dongola chert.

Early Woodland chipped stone tools manufactured from non-local chert include two varieties, Burlington chert and Wyandotte chert. Middle Woodland chipped stone tools are also manufactured from Burlington chert and Wyandotte chert, as well as Cochrane chert. For both components, most chipped stone tools of non-local lithics are manufactured from Burlington chert.

Table 4.7. Relative Frequencies of Local and Non-Local Lithic Raw Materials by Component

	Early Woodland	Middle Woodland
Chipped Stone Tools: Local Raw Material	92.53	88.18
Chipped Stone Tools: Non-Local Raw Material	7.47	11.82
Waste Flakes Local Raw Material	97.42	97.55
Waste Flakes: Non-Local Raw Material	2.58	2.45

Table 4.8. Source Areas of Lithic Raw Materials

Raw Material	Source Type	Source Area
Galena	Local	WI (southwest, southeast, south-central), IL (northwest), MN (southeast), IA (northeast)
Burlington	Non-Local	IA (southeast), IL (west-central)
Orthoquartzite	Non-Local	WI (southwest)
Wyandotte	Non-Local	IN
Cochrane	Non-Local	WI (western)
Dongola	Non-Local	IN, IL (southern)

The non-local raw materials represented in the assemblages indicate that interaction with groups to the south were initiated by the time of the Early Woodland component. The data indicate a modest increase in non-local raw material for chipped stone tool manufacture associated with the Middle Woodland component as compared to the Early Woodland component. The presence of Dongola chert in the Middle Woodland assemblage, and absence from the Early Woodland assemblage, suggests that interaction was more far-reaching during the Middle Woodland, extending to southern Illinois and Indiana, as compared to the Early Woodland.

Summary

The Finch site harbors well documented and spatially discrete Early Woodland and Middle Woodland occupations that span the later part of the Early Woodland through Middle Woodland, offering a comprehensive accounting of a domestic/household habitation. Seasonality of occupation for both the Early and Middle Woodland components occurred between April/May to November, with evidence suggesting more intensive site use, for both components, during the fall months (Haas 2019).

The Early Woodland component is largely confined to a single activity area within the southern portion of the site. This activity area defines domestic space, consisting of a temporary structure (house) flanked by numerous cooking pits, multi-functional pits, and a few post molds. The Middle Woodland component consists of cultural features and several activity areas, located throughout the site, with notable concentrations situated to the north and south of the Early Woodland occupation. The more northern activity area in Region C defines a living space where domestic tasks, including cooking, occurred within and near to a house. The more southerly area, in Region D, delineates a space where intensive animal resource processing took place. Cooking pits are associated with both loci and represent at least two distinct types. Four AMS dates have been secured for the Early and Middle Woodland occupations of the Finch site. The data indicate both cultural and temporal overlap, not an unexpected occurrence given the current cultural-historical paradigm that posits the emergence of Middle Woodland from local Early Woodland antecedents and similarity to southwestern Wisconsin, as noted above. A review of the raw material profiles associated with each component indicates a heavy reliance of locally available Galena chert by both the Early and Middle Woodland occupations. Non-local raw materials exhibit similar types and frequencies for both the Early and Middle Woodland occupation, indicating a connection to southwest and south-central Wisconsin, west-central, north-west, and southern Illinois, southeast Minnesota, northeast Iowa, and Indiana.

CHAPTER 5: CERAMIC ANALYSIS

Introduction

This chapter presents the results of the ceramic analysis conducted on the Early and Middle Woodland Finch site ceramic assemblage. The ceramic analysis employs morphological (attribute-based) and functional approaches, using the vessel as the unit of analysis, to directly address aspects of each of the five research questions (see Chapter 2). The morphological analysis builds upon the data collected as part of the previous ceramic study completed for the CRM project. Attributes relating to morphology, manufacture, and decoration are reviewed, refined, and recorded for each vessel. The attribute analysis allows for a formal comparison of Early and Middle Woodland ceramic technology as well as providing data crucial to an understanding of vessel function.

New functional analyses of the ceramic vessels is undertaken as part the dissertation project (Schiffer 2014; Schiffer and Miller 1999; Skibo 2013, 2015). Ceramic use-alteration, the material manifestation of intentional interaction between people and pottery, reflects the role of ceramics in everyday life, relative to both culinary and non-culinary functions (Blitz 1983; Braun 1983; Hally 1983; Kobayashi 1994; Kooiman 2016; Skibo and Blinman 1999; Skibo et al. 2009; Skibo 1992, 2013). Cooking pots are part of the "largely unconscious business of daily living and tend to persist untouched by contact or by changing fashion" (Linton 1944:369). The functional analysis identifies the intended and actual use of individual vessels through macroscopic techniques (fire alteration and attrition) and chemical analyses.

An overview of the data set used for the attribute-based and functional analyses is first presented followed by a review of the methods. The results of the attribute based analysis are then discussed, describing the composition of the assemblage in terms of morphology, manufacture, and decoration. The functional analysis, following the morphological study, examines the intended and actual vessel functions. The results of the chemical residue analysis is included in the discussion of actual vessel function.

Overview of the Data Set and Previous Studies

The ceramic assemblage associated with the Early and Middle Woodland occupations of the Finch site consists of over 9,000 sherds from which 72 discrete vessels have been delineated (Picard and Haas 2019) (Table 5.1; Appendix D). The ceramic analysis completed for the associated cultural resource management report conducted a mass analysis of all ceramic sherds and identified individual vessels that were classified according to existing regional types (Picard and Haas 2019). The range of variation associated within each typological class was presented based on morphological, compositional, and decorative attributes.

The mass analysis recorded sherd type (rim, body, or fragment), temper, surface treatment, decoration, count, and weight. The rim sherds and decorated body sherds were subjected to further study using the vessel as the unit of analysis. Rims were used to initially determine the number and types of vessels present in the assemblage. Vessels were further identified on the basis of form, temper, paste, surface treatment, and decoration. Re-fits, decorative similarity, unique vessel form or manufacturing technique, as well as provenience, also permitted sherds to be assigned to a specific vessel.

The cultural resource management project collected quantitative and qualitative data from vessels as well as for the rim sherds and decorated body sherds that could not be confidently assigned to a vessel. Quantitative measures consisted of mean wall thickness and, for those vessels where at least five percent was represented, orifice diameter. Qualitative attributes, following the methods of Richards (1992) and Koldehoff and Galloy (2006), consisted of vessel form, temper size, compactness, rim stance, rim shape, lip shape, paste type, oxidation, and decoration. Photographs and rim profiles were completed for each vessel (Picard and Haas 2019) (Appendix D). The results of the attribute analysis were structured using a typological classification system. A description of the typological classifications are provided below.

Table 5.1. Ceramic Vessels and Typological Classification of the Early and Middle Woodland Components at the Finch Site (47JE0902)

Component - Typological Classification	Number of Vessels	Percent
Early Woodland		
Dane Incised	22	81.48
Dane Punched	1	3.70
Prairie Ware	4	14.82
Total Early Woodland	27	100.00
Middle Woodland		
Deer Creek Incised	1	2.22
Shorewood Cord-Roughened	21	46.68
Kegonsa Stamped	12	26.67
Havana Zoned	2	4.44
Havana Plain	2	4.44
Naples Stamped	3	6.67
Sister Creeks Punctate	1	2.22
Other Hopewell-Related	1	2.22
Middle Woodland Seed Jar	1	2.22
Douglass Net Marked	1	2.22
Total Middle Woodland	45	100.00

Early Woodland Ware Types

The Incised Over Cord Marked (IOCM) class encompasses the broadly defined Dane Incised type that was originally defined by Baerreis (1952). As described by Keslin (1958:204), the ware has a coarse, friable paste and cordmarked exterior surface, and primary decoration consisting of carelessly executed, incised lines in angular patterns. Other decorative modes consist of cord-wrapped stick impressions and parallel horizontal lines as the favored mode. Later researchers have expanded upon and refined the type including Salzer (n.d.), Mason (1966), Hurley (1974) and Salkin (1986). Dane Incised ware typed from the Highsmith (47JE0004) and Cooper's Shores (47RO0002) sites are typically decorated with diagonal incised lines with occasional nodes and stamps on the interior lip margin (Salzer n. d.).

Based on excavations at the Lake Farms Archaeological District in Dane County, Salkin (1986) proposed two new types for the IOCM wares, arguing that the type had been too broadly defined and indiscriminately applied to a wide variety of forms. The new ware types include Beach Incised and Waubesa Incised. Beach Incised vessels are similar to Baerreis's (1952) original definition of Dane Incised with a globular form, fairly compact paste, and flat lips decorated with bands of oblique or horizontal incised lines often bordered by punctates. Some vessels may have more complex designs with alternating bands or "filled triangles" with fingernail impressions (Salkin 1986:99). Salkin (1986) describes Waubesa Incised vessels as conoidal or subconoidal forms with more friable pastes, frequent diagonal lines, and broader, shallower incising as compared to Beach Incised.

Incised over Cord Marked wares are associated within Early Woodland occupations in southeastern Wisconsin. However, investigations at Mero (47DR0083) in the Door Peninsula extended the IOCM type into the Middle Woodland (Mason 1966; 1981). Hurley (1974) proposed a Dane Incised: variety Fingernail Impressed for those examples which display fingernail stamping on the lip or rim. Similar to Mason's (1966) work, Hurley's (1975) analysis also extended the type considerably later into prehistory.

Given the temporal and stylistic ambiguity surrounding Dane Incised and related types, the Finch site vessels were classified into a broadly defined IOCM category.

Dane Punched vessels exhibit a similar texture and temper to Dane Incised and are decorated with parallel rows of fingernail impressions. Typically, these impressions form diagonal lines across the upper rim, but horizontal and vertical rows also appear on the vessel. Nodes occur but are rare on Highsmith specimens (Salzer n.d.). Often the lips of Dane Punched vessels exhibit cord or fabric impressions. Salzer (n.d) suggests that this type is associated with the Early Woodland period and continues into the Middle Woodland (Salzer n.d.).

Prairie Ware vessels are diagnostic of the Early Woodland Prairie phase in southwestern Wisconsin (Stoltman 1986). These vessels have a sandy paste and are often decorated by bosses or incised decoration (Stoltman 1986:123). Types include Prairie Incised, which has incised-over-cordmarked decoration (often over the majority of the vessel), and Prairie Bossed, defined by the use of nodes as sole decoration. Prairie Linear Stamped features parallel rows of fingernail stamps and Prairie Corded Stamp is decorated with short cord-wrapped stick impressions (Stoltman 1986, 1990).

Deer Creek Incised represents a transitional Early to Middle Woodland ware type. Deer Creek Incised ware was defined by Salzer (n.d.) based on investigations at the Highsmith and Cooper's Shores sites (Salzer n.d, 1965). The vessels consist of a compact, crushed granitic rock paste with cordmarked lips and exterior surface. Decoration consists of an upper band of vertical fingernail impressions and a lower rim band of horizontal incised lines.

Local Waukesha Phase Vessels

Two ware types are recognized as diagnostic of the Waukesha Phase and include the types Kegonsa Stamped and Shorewood Cord-Roughened. Both wares were initially defined by Baerreis (1952) and then further described by Salzer (n.d.) based on the Highsmith and Cooper's Shores site assemblages. Salzer (n.d) groups Kegonsa Stamped and Shorewood Cord Roughened within the Rock ware category, drawing similarities with Havana ware based on decorative modes such as dentate stamping, cord-wrapped stick and plain stamping, nodes, beveled lips and vessel form.

Kegonsa Stamped vessels are tempered with crushed granite and sand with cordmarked, smoothed-over-cordmarked, and/or smoothed surface treatments. Decoration typically involves cord-wrapped stick stamp or plain stamp on the interior or exterior of the vessel and the presence of nodes. Nodes are especially prevalent on cord-wrapped stick stamped vessels. At the Silver Creek site in central Wisconsin, the primary decoration of Kegonsa Stamped vessels consists of a single row of exterior nodes placed horizontally on the rim and a series of parallel cord-wrapped stick or cord-impressions on the upper rim and lip surface, producing a crenellated appearance (Hurley 1974:28).

Shorewood Cord Roughened vessels define conoidal (and sub-conoidal) jars with direct or slightly inslanting rims, and pastes that are similar to Kegonsa Stamped. Nodes exist in the rim area of some vessels and are the sole decorative treatment found on this type. Hurley (1974) expanded the definition of Shorewood Cord-Roughened to include vessels with cord-wrapped stick stamping on the interior lip margin. However, Stoltman (1990) concurs with Baerreis (1952) by including interior stamping under the Kegonsa Stamped label (1979). For the Finch site vessels, the typological classifications adheres to the original description by Baerreis (1952), with nodes as the sole decorative treatment.

Douglass Net-Marked is defined by a surface treatment consisting of knotted net impressions (Hall 1962). Douglass Net-Marked is similar to Baraboo Net-Marked but differs in that the latter contains crushed shell temper and the former is grit-tempered (Wittry 1959). While the exact temporal and cultural associations for Douglass Net-Marked remain poorly understood, Salkin (2000) and Stevenson et al. (1997) propose a late Middle Woodland/early Late Woodland affiliation.

Havana Ware Vessels

The Havana ceramic tradition was initially defined for the Lower Illinois River Valley by Griffin (1952) and includes a number of different types such as Havana Plain, Havana Zoned, Naples Stamped, Baehr Zoned, Sister Creeks Punctate, Morton Incised, Hummel Stamped and a number of other types (Griffin 1952; McGregor 1952). The classic vessel form for Havana ware consists of jars with nearly vertical walls, straight rims, slightly constricted orifices and flattened, inwardly beveled lips. Lip notching, cord-wrapped stick stamping and dentate stamping are also common (Griffin 1952). Havana ware types identified in the Finch site assemblage inlcude Sister Creeks Punctate, Naples Stamped, Havana Zoned, and Havana Plain.

Vessels classed as Sister Creeks from the type site in the Central Illinois River Valley are decorated with circular punctates, oblique gouges and oval punctates (Meinkoth et al. 1995: 64). Griffin (1952) classified Sister Creeks Punctate as part of the Early Woodland series that also extends in to the early Middle Woodland period.

Naples Stamped was described by Griffin (1952) based on examples from Naples Mounds in the Illinois River Valley. The vessels display stamping, such as dentate or cord-wrapped stick forms, over a smoothed or cordmarked surface. Middle Woodland sites in Illinois and southwestern Wisconsin frequently feature this type (Freeman 1969; Hurley 1974; Stoltman 1979). The dentate variety of Naples Stamped is cited as the most prevalent of the Illinois Havana types represented in the Trempealeau phase of southwestern Wisconsin (Stoltman 1979, 2005). In the Rock River valley, a Naples Ovoid Stamped example was identified at the Highsmith site (Salzer n.d.).

The identification of Havana Zoned vessels is dependent upon the presence of decorated body sherds or sufficiently large rim sherds for zoning to be visible (O'Brien and Wood 1998: 191). Decoration consists of curilinear trailed lines set into a smoothed surface that form a distinctive zoned type pattern (Fortier 2008; Griffin 1952). Havana Zoned and similar types are found in the Illinois River Valley as well as at a number of sites outside the lower Illinois Valley.

Griffin (1952) differentiates Havana Plain from Havana Cordmarked by the fact that the former features a smoothed surface, while the latter is cord-roughened. Salzer (n.d) identified examples of smoothed, noded vessels as a local "Rock ware" type, defined as Highsmith Plain.

Classic "Hopewell ware" is generally tempered with limestone in the Illinois Valley where that material is abundant; elsewhere other temper types may be used (Griffin 1952:115). Griffin (1952) identifies these vessels as thin-walled. The "classic Hopewell" ware from the Highsmith site in the Rock River valley is tempered with limestone (Salzer n.d.).

Early and Middle Woodland Vessels Data Set

The ceramic data used for this dissertation project includes all of the vessels identified as part of the cultural resource management project that are typologically classified as Early and Middle Woodland ware types. The vessels are identified as Early Woodland or Middle Woodland based on stylistic criteria, linked to typological classification, that are grounded in widely accepted regional norms (Benchley et al. 2007; Boszhardt et al. 1986; Salzer n.d.; Stevenson et al. 1997). These schema recognize Early Woodland vessels as grit-tempered and decorated with bands of horizontal or diagonal lines over cord-marked surfaces, sometimes also exhibiting nodes or punctates. Middle Woodland vessels, most frequently grit-tempered with few instances of shell-tempering, exhibit a variety of stamped motifs such as dentate, rocker, and/or cord-wrapped stick stamping, as well as punctates and nodes.

In all, a total of 72 vessels are included in the ceramic analysis for this dissertation project, consisting of 27 Early Woodland and 45 Middle Woodland vessels. The 72 vessels are composed of 1115 sherds, weighing a total of 10878.54 grams (Table 5.2). Photographs and rim profiles of the vessels are included as Appendix D.

Table 5.2. Overview of the Early and Middle Woodland Vessel Assemblage

Component	Vessel Count	Rim		Body		Total	
		Count	Weight (g)	Count	Weight (g)	Count	Weight (g)
Early Woodland	27	125	1564.3	152	1328.94	277	2893.24
Middle Woodland	45	389	4609.71	449	3375.59	838	7985.3
Total	72	514	6174.01	601	4704.53	1115	10878.54

Methods

The methods employed in the attribute analysis and functional study are presented below.

Morphological (Attribute) Analysis

The morphological analysis builds upon the data collected as part of the previous ceramic study completed for the CRM project. Attributes relating to morphology, manufacture, and decoration are reviewed, refined, and recorded for each vessel. The attribute analysis allows for a formal comparison of Early and Middle Woodland ceramic technology as well as providing data crucial to an understanding of vessel function.

Vessel Morphology

Morphological aspects relate to the overall shape and form of the vessel. The pottery vessel has three primary components consisting of the orifice, body, and the base (Rice 1987) (Figure 5.1). The orifice is the opening at the top of the vessel and base is the bottom of the vessel. The base may be more easily distinguishable in flat-based vessels as compared to round or conical vessels. The body is the part of the vessel between the orifice and the base. The vessel orifice is further described relative to the rim and lip. The lip is the edge of the vessel opening, or the location at which the interior of the vessel meets the exterior. Rims are the portion of the vessel nearest the orifice. Qualitative and quantitative observations pertaining to vessel morphology consist of vessel form, rim form, lip form, orifice diameter, and wall thickness.

Vessel Form

Vessel form refers to container shape categories that have become conventionalized in Midwestern ceramic studies (Richards 1992). Vessels are categorized on the basis of the shape or form as determined by the primary components of the vessel: orifice, body, and base (Rice 1987). Vessel shape is associated with vessel function or use; however not all vessels were used for the purposes for which they were originally intended (Shepard 1956; Sinopoli 1991; Skibo 2013). All of the

Early and Middle Woodland vessels from Finch are jars. Jars typically exhibit restricted orifices that are smaller in diameter than the maximum vessel diameter. Jars commonly have necks and may have shoulders. Jar forms are further categorized according to variation in neck and shoulder morphology as conoidal, sub-conoidal, globular, and neckless (seed-tecomate) forms (Figure 5.2).

Rim Form

The rim defines the area of a vessel between the lip and neck. Rims are easily identifiable on those vessel forms exhibiting curvature to the neck or vessel wall (Rice 1987). Rim sherds provide much information regarding vessel shape and size; diagnostic styles are often used as chronological indicators (Rice 1987:222; Shepard 1956:245). Two aspects of the rim, stance and shape are recorded for each vessel.

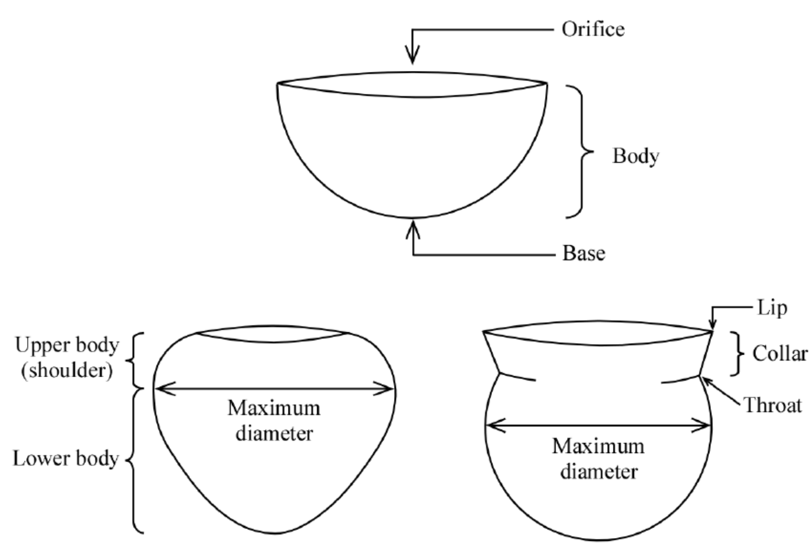


Figure 5.1. Anatomy of a vessel (adapted from Rice 1987).

Rim stance describes the orientation of the rim to the horizontal plane that defines the opening of the vessel. Rim stances are recorded for those vessels where at least 2.5 cm of the lip is present. Rim stance types represented in the Early and Middle Woodland ceramics from Finch include direct, everted, slightly everted, slightly inverted, and indeterminate (Figure 5.3). Direct rims describe those vessels lacking a change in orientation between the lip and the vessel wall, thus having an indeterminate rim height (Shepard 1956). Everted and slightly everted rims have an orientation of the rim to the horizontal plane exceeding 90 degrees. For slightly everted rims, this angle falls between 90 to 115 degrees while everted rims have an angle that exceeds 115 degrees. Slightly inverted stances exhibit a rim angle of less than ninety degrees.

Rim shape defines the change in wall thickness from the neck of a vessel to the lip and are classified as unmodified, folded, thickened, and pinched. Unmodified rims have straight walls

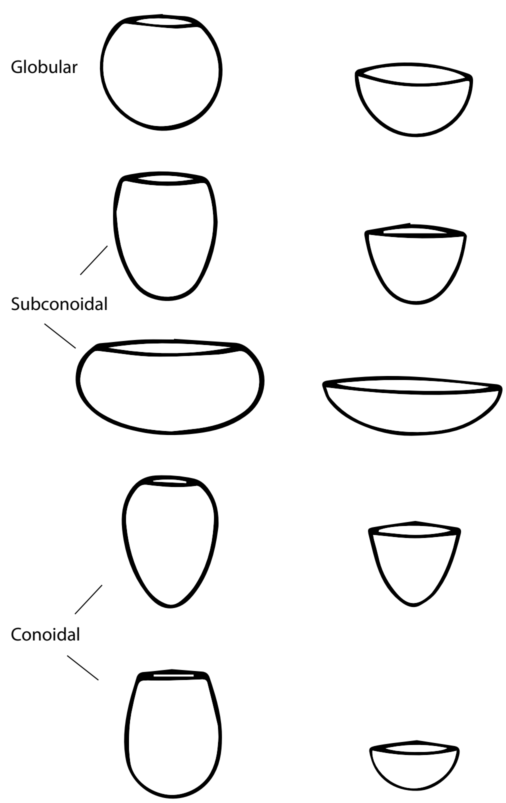


Figure 5.2. Jar forms represented by the Early and Middle Woodland ceramic assemblage at the Finch site (adapted from Rice 1987).

of consistent thickness from the neck to the lip. Folded rims have a fold of clay on the exterior rim margin with a visible crease at the lower rim margin and neck. Thickened rims have vessel walls that are more narrow towards the neck and thicker near the lip. Pinched rims have a greater thickness towards the lower rim margin and decrease in thickness towards the lip. As multiple rim shapes may be present on a single vessel, all observed shapes are recorded for each vessel.

Lip Form

The lip defines the edge of the vessel opening, the junction of the exterior and interior surfaces. Three lip forms are observed in the vessel assemblage, consisting of flattened, rounded, and beveled (Figure 5.4). Flattened lips create a planar surface along the outer rim margin on a direct rim. On everted rims, the planar surface of the flattened lip separates the outer and inner rim margins (Richards 1992). Rounded lips have a gentle convex appearance. Beveled lips exhibit flattening of the rim towards the exterior and/or interior of the vessel, creating a sharp point due to sloping.

Orifice Diameter

Orifice diameter is recorded for those vessels where at least five percent of the vessel is represented. Orifice diameter is estimated to the nearest centimeter through a comparison of rims with a set of concentric circles plotted on graph paper. The estimate of the percentage of vessel orifice represented is also determined using this method. Orifice diameters are only reported for those vessels represented by five percent or more of the vessel. A *k*-means cluster analysis, based on the quantitative measurement of orifice diameter, is used to classify the vessels into four categories: small, small-medium, medium-large, and large (Rogerson 2010).

Vessel Wall Thickness

A digital calipers is used to measure an area of the vessel just below the lower rim margin. The average of three measurements is recorded as the vessel wall thickness. A *k*-means cluster analysis is conducted to classify the vessels into two size categories: thin and thick (Rogerson 2010).

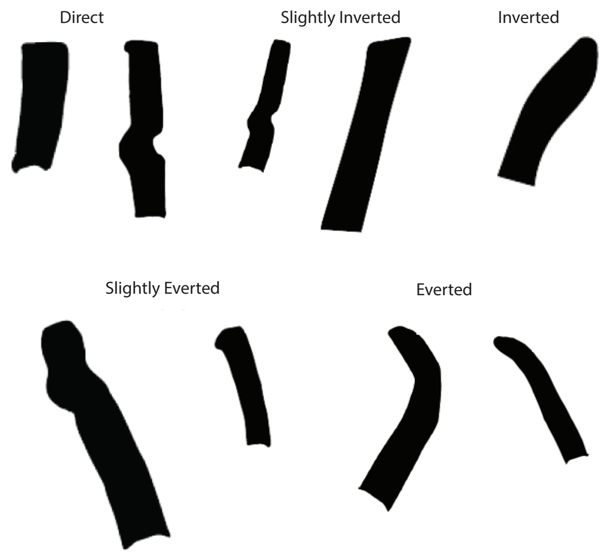


Figure 5.3. Rim stance types in the Early and Middle Woodland ceramic assemblage at the Finch site.

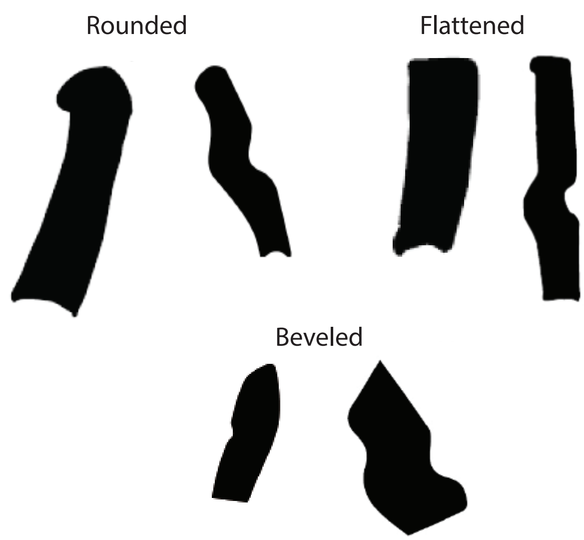


Figure 5.4. Lip form types in the Early and Middle Woodland ceramic assemblage at the Finch site.

<u>Vessel Manufacture</u>

Attributes recorded relative to vessel manufacture include paste characteristics, temper type and macrosocpic composition, and exterior/interior surface finish.

Paste Core, Consistency, and Fracturing

The paste core coloring indicates the types of firing and cooling atmospheres the pottery vessels were subjected to during production (Rice 1987; Rye 1981; Sinopoli 1991). In a reduced atmosphere, the restricted air flow to the vessels results in carbon accumulation on the exterior surface that may penetrate to the core. In an oxidized environment, the unrestricted air flow allows for the carbon to burn off resulting in a light vessel color. Based on these principles, light colored cores indicate an oxidized atmosphere and dark cores correlate with a reduced environs. If multiple methods are used during the firing process, distinctive patterning of light and dark may be present on the vessel surfaces (interior and exterior) and core. Seven categories are used to describe the paste cores in the Early and Middle Woodland vessel assemblage (Table 5.3).

The consistency and fracturing of the paste is described as compact or friable. Friability is affected by post-depositional processes, such as weathering, as well as secondary firing that can weaken the integrity of paste (Schneider 2015:159). A compact paste structure exhibits a dense clay in profile and lacks easy fracturing. A friable paste manifests a weaker structure and may fall apart when handled.

Temper

Temper is analyzed based on macroscopic characteristics using a 10x hand lens. All vessels in the assemblage are tempered with grit and/or sand. Grit is further described by the presence/absence of inclusions such as sand, feldspar, and mafic rocks.

Surface Finish

Surface finish is recorded for the interior and exterior walls of vessels with intact surfaces (that not exfoliated or eroded). Surface finishes consist of plain surface, smoothed, cord-marked, smoothed over cord marked, and net-marked.

Vessel Decoration

Decorative forms present in the assemblage include trailing, nodes/bosses, stamping (cord-wrapped stick, dentate, stamp and drag), punctates, notching, fingernail impressions, and cordmarking. The decorative elements and modes observed on each vessel are described, noting the vessel location.

Table 5.3. Vessel Manufacturing Attributes: Oxidation Patterns

Code	Description
OX1	Fully oxidized
OX2	Fully reduced
OX3	Exterior surface oxidized, interior surface reduced
OX4	Exterior surface reduced, interior surface oxidized
OX5	Reduced interior and exterior surface, oxidized core
OX6	Oxidized exterior surface, reduced core
OX7	Uneven - no consistent pattern

Functional Analysis

A functional analysis is conducted on the Early and Middle Woodland vessels that identifies intended and actual use of individual vessels through macroscopic techniques and chemical analyses. Intended function examines vessel morphology and manufacture that relate to the performance attributes of a pot to assess how a vessel was designed to be used (Rice 1987; Skibo 1992, 2013). Actual function, or use-alteration, addresses how vessels were actually used through characteristics of exterior and interior sooting and attrition (Skibo 1992, 2013). Chemical residue analysis further addresses actual use by identifying remnants of plant and animal remains preserved in the ceramic fabric (Anderson et al. 2017; Craig et al. 2011; Evershed 2008a, 2008b, Hansel et al. 2011; Malainey et al. 1999, 2001; Reber et al. 2010; Reber and Evershed 2006; Skibo et al. 2016). The assessment of intended and actual function allows for the classification of ceramic vessels as used primarily for cooking, serving, transport, and/or storage (Skibo 2013). A functional analysis further delineates specific activities associated with cooking vessels including hearth design, cooking type (direct or indirect), and cooking mode (wet or dry) (Beck et al. 2002; Driver and Massey 1957; Hally 1983; Kooiman 2016; Sassaman 1991, 1993).

The data set for the functional analysis consists of the 72 vessels associated with the Early and Middle Woodland components. Although no complete vessels were recovered from the Finch site, and none of the partial vessels have been reconstructed, this study records use alteration for each sherd associated with a particular vessel (Table 5.2). Although examination of a whole vessel is important in functional analysis, as use-alteration traces may not be fully evidenced on sherds, patterns observed on reconstructed vessels can be used as baseline comparisons for the sherd data (Kooiman 2016; Sassaman 1991, 1993; Skibo 2013). For this study, patterns recorded for the more complete vessels guide the interpretation of the less complete vessels.

Intended Function

Intended function, those aspects of vessel manufacture that measurably enhance performance, is assessed using vessel morphology (general form, size, and rim orientation), vessel wall thickness, temper characteristics, and surface treatment (Braun 1983, 1987; Hally 1983; Kooiman 2016; Reid 1990; Rice 1987; Rye 1976; Schiffer et al. 1994; Skibo 2013).

Vessel shape and size provide information regarding the vessel's intended function relative to capacity, stability, accessibility, and transportability (Braun 1980; Hally 1986; Rice 1987; Shapiro 1994; Shepard 1956; Skibo 2013). Larger vessels may be associated with storage. Smaller vessels may enhance performance during heating tasks, short term storage, and/or storing foods that spoil quickly. Rounded base forms are more effective over heat as compared to flat bottom bases (Braun 1983; Rye 1976). Restricting orifice size can increase heating effectiveness, important for bringing pot contents to boil quickly (Sassaman 1993). Cooking vessels typically have vertical or everted rims with somewhat restricted orifices, forms effective at heat retention but that also allow relative ease of access to contents (Kooiman 2016; Rice 1987; Skibo 2013).

Vessel wall thickness and uniformity of thickness affects heat conduction as well as resistance to mechanical and thermal stress (Braun 1983; Rice 1987). Thinner walls promote the efficient and even conduction of heat from the exterior to the interior wall, decreasing the stress caused by exterior and interior vessel wall temperature differentiation, reducing fuel consumption, and decreasing cooking time (Schiffer and Skibo 1987; Skibo 2013). Thinner walls increase resistance to thermal shock, the strain caused by rapid heating and cooling and by long-term exposure to high temperatures (Rice 1987:369). Resistance to thermal shock is an especially important trait in pots used for sustained boiling.

Thick wall vessels provide a high degree of mechanical strength, but are less efficient at heating as compared to vessels with thinner walls. Thick walled vessels are better designed to absorb mechanical shock without distorting or failing (Braun 1983; Pierce 2005). Thicker walled vessels allow for long periods of lower temperature cooking and can be left on the fire with little tending or risk of boil overs.

Surface treatment/texturing, temper, and rounded bases improve thermal shock resistance, the primary performance characteristic in low-fired cooking pots (Kooiman 2016; Schiffer 1990; Young and Stone 1990; Pierce 2005). Surface treatment plays an important role in vessel performance relative to permeability, thermal shock resistance, abrasion resistance and heating effectiveness, as well as other functions (Schiffer et al. 1994; Skibo 2013). Interior surface treatments that have some permeability increase thermal shock resistance. Vessels with the least permeable interior surfaces have the greatest heating effectiveness (Schiffer 1990). Thermal shock resistance is also influenced by a number of surface treatments (Schiffer et al. 1994).

Temper (non-plastic inclusions) are related to cultural factors, but also impact vessel performance during manufacture and use (Bronisky and Hamer 1986; Braun 1983; DeBoer 1984; Reid 1984; Skibo 2013; Steponaitis 1983, 1984). Paste composition performance characteristics include workability (less workable with more mineral temper, dry organic temper more workable), ease of manufacture (temper and paste properties, higher percentages of mineral temper more difficult to manufacture), thermal shock resistance (more temper and pore spaces increase thermal shock resistance), cooling effectiveness (pots with more mineral temper have greater permeability and better cooling effectiveness), portability (organic temper is lighter), impact resistance, and abrasion resistance (temper type and amount) (Skibo 2013).

Actual Function (Use Alteration)

The reconstruction of intended function may not directly concord with the manner in which vessels were actually used (Shepard 1956; Skibo 2013, 2015). A potter may design a vessel to perform specific functions but the vessel may subsequently function in a very different way (Skibo 2015). Actual function examines how vessels were actually used through identification of macroscopic use-alteration characteristics (sooting, oxidation, and attrition) and chemical residue analysis.

Sooting

Interaction with fire is an important source of alteration on ceramics (Banducci 2014). Ceramics exposed to heat develop patches of black discoloration on their surface. This blackening represents deposited carbon, resulting from the combustion of organic material, that becomes affixed on, or in some cases into, the porous and permeable ceramic wall (Skibo 1992). The presence of sooting provides unequivocal evidence for the use of a ceramic vessel over a fire (or coals) for cooking and/or processing tasks (Hally 1983). Moreover, the location and patterning of sooting informs about specific activities related to cooking and processing, including hearth design, cooking type, and cooking mode (Hally 1983; Skibo 2013).

Three types of exterior sooting occurs during cooking, consisting of free carbon deposits, distilled resin accumulation, and oxidation of the vessel surface (Hally 1983; Skibo 2013:90-92). Temperature, both of the fire and the vessel surface, determines the form of exterior soot (Skibo 2013). Free carbon from wood fuels deposits on the ceramic surface soon after a pot is put on or in a fire, typically covering the entire vessel from the base to the shoulder (Skibo 2013). Flat black and fluffy, free carbon easily washes off following use (Skibo 2013). Free carbon soot is typically not preserved in the archaeological record, especially in open air sites, due to percolating water, bioturbation, and other post-depositional processes (Skibo 2013:90).

Distilled resins, emitted during wood combustion, adheres to the ceramic surface when the vessel surface reaches 300° C to 400° C (Hally 1983; Skibo 2013). Once cooled, the resin produces a hard, waterproof layer resistant to breakdown in the depositional environment and thus the most common type of soot preserved in the archaeological record (Beck et al. 2002; Skibo 2013:91). Distilled resin soot is black in color, has a lustrous quality, and builds up over the use-life of a vessel. As resin deposition requires a comparatively cool surface, relative to the temperature of the fire or coals, this type of soot typically occurs on vessels used to cook liquids. Liquid contents tend to moderate vessel wall temperature. The pouring out of the liquid or a boil over, where food residue drips down the outside of the vessel, may also cause distilled resin to become affixed to the vessel exterior (Kooiman 2016).

Exterior oxidation occurs when the temperature of the ceramic surface exceeds 400° C (Skibo 2013). At this temperature, free carbon and distilled resins are completely burned away and no soot can be deposited on the hot vessel surface. Oxidation patches are common on vessels placed directly on coals or vessels in which liquids are boiled away. These patches may vary from a gray color, reflecting a light coating of soot, to a completely oxidized surface.

Distinguishing oxidation from use (exposure to fire) versus manufacturing (fire clouding) is difficult, especially when working with partially complete vessels and sherd collections (Skibo 2013). Low temperature fired pottery typically has a black or gray color produced by the presence of free carbon and organic matter in the paste (Hally 1983). When heated in an oxidizing atmosphere, the organic matter decomposes at temperatures above 200° C and, at 500° C, the released carbon oxidizes and dissipates as carbon dioxide (Shepard 1956:217-220; Rye 1981:108; Hally 1983). Complete oxidation of carbonaceous materials results in pottery colors ranging from white to buff to red (Hally 1983).

Differential access to air during firing and cooling can cause considerable variation in the surface color of a single vessel (Rye 1981:120). Fire clouds, random patches of carbonization on the vessel exteriors, is caused by fuel contact with the vessel, such as when a jet of gas from a smoky flame or the flame itself strikes the vessel during firing (Rye 1981; Skibo 2013:108; Shepard 1956). Fire clouds are similar to smudging, the process of purposefully creating a reducing atmosphere during firing to create, in the presence of organic matter, a blackened surface appearance (Longacre et al. 2000; Rice 1987:158; Schiffer 1988, 1990; Shepard 1956; Skibo et al. 1997; Skibo 2013:108). Smudging, fire clouding, and exterior sooting are all similar in that carbonized matter is deposited on, and in some cases slightly in, the vessel wall. The primary factor distinguishing carbon deposited as soot during use from carbon deposited during firing is in the overall pattern observed on a whole vessel (Skibo 2013:109). In general, fire clouds are not as common as sooting and rarely occur on the vessel interior (Skibo 2013:109). Sooting "tends to be radially symmetrically in patterns that recur on different vessels of the same morphological type" (Skibo2013:109). Oxidation from cooking is typically localized on portions of the vessel exterior (Hally 1983).

Interior carbonization, or charring, results from organic material oxidizing after having lost all moisture, frequently the source of blackening on the interior vessel walls. As with exterior sooting, charring occurs when the vessel surface exceeds 300° C and is attributable to both dry and wet mode cooking. In wet-mode cooking, pottery surfaces reach these high temperatures above the water line, creating a "scum" or "water" line (here "water" references water or some other type of liquid). Several scenarios cause charring below the water/liquid line in wet mode cooking. As liquid boils away, food particles may become trapped on the interior vessel surface, burning and depositing carbon. For example, placing a vessel on or above a fire or coals may cause foodstuffs at the base to dry out and carbonize. The organic matter within the liquid contents may absorb into the vessel wall and then char during a subsequent heating episode (Banducci 2014; Skibo 1992: 148-151; 2013:84-92). Interior charring may also result from dry mode cooking, a process by which water cannot act to temper the heating process, typically producing charring throughout much of the vessel interior (Kooiman 2016; Skibo 2013:97).

Exterior sooting/oxidation and interior carbonization is identified using low magnification (10x to 40x) as a distinct black, lustrous layer on the ceramic surface, sometimes with a granular, bubbly, or finely cracked surface texture (Beck et al. 2002; Hally 1983) (Figure 5.5). Vessels with more ambiguous evidence for sooting are grouped as possibly sooted. These vessels exhibit dark surface stains that lack luster and the granular surface characteristics of soot deposits but are too irregular and discontinuous in their distribution to represent fire clouding. The presence/absence of soot is recorded for the interior and exterior of each vessel sherd noting its vessel position (rim/upper body, mid-body, lower body, and base) (Figure 5.6). A qualitative description of the

Figure 5.5. Examples of exterior and interior sooting.

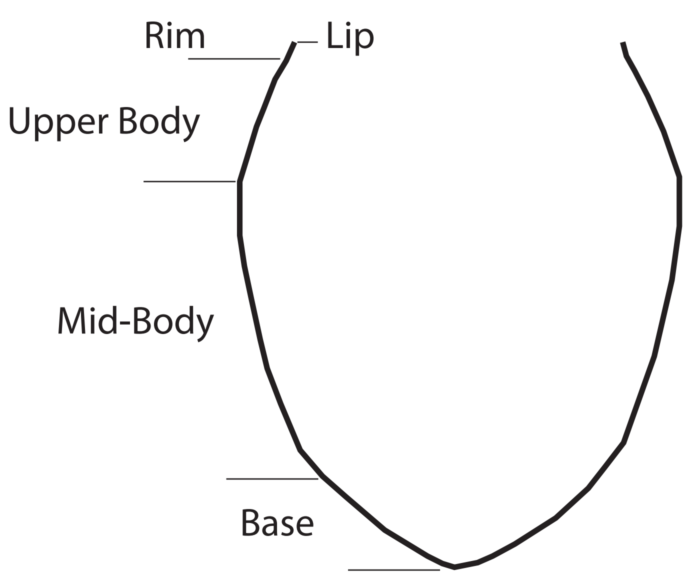


Figure 5.6. Description of the vessel location recorded for sherds exhibiting interior carbonization and exterior sooting.

soot patterns is provided for each sherd (banded, patchy, covers entire sherd surface) associated with a vessel. A vessel diagram is used to document the patterning of exterior soot and interior carbonization based on the sherd data. The vessel diagrams are then used to sort the vessels into distinct types of interior and exterior carbonization.

Attrition

The types and location of attrition on the ceramic vessel inform about vessel function, cooking practices, and frequency of vessel use (Skibo 1992, 2013). Attrition patterns from use represent abrasive processes that have removed ceramic surface material (Skibo 2013). On the ceramic surface, these processes manifest as linear scratches, patching, chipping, and/or temper pedestaling (Banducci 2014; Skibo 2013). Many different types of actions can produce abrasion on the ceramic surface, including tool use. Utensils used for cooking and eating (stirring, scooping, cutting, scraping) have prolonged and repeated contact with the interior, and sometimes exterior, ceramic surface, leaving distinctive marks (Banducci 2014; Bray 1982; Duddleson 2008; Griffith 1978). Abrasion resulting from distribution or storage is another source of use alteration on pottery (Skibo 1992). The dragging of a pot along a surface, placement on a shelf, or contact with other vessels reflect sources of "unintentional" abrasion (Banducci 2014:192). Pedestaling is created by gentle abrasion by material that has a diameter less than the distance between temper particles, such as through contact with hearth soil (Skibo 1987; 1992:116). Turning and tipping of a vessel, especially during serving, may also result in pedestaled temper (Skibo 1992:116).

Ethnoarcheological research has identified distinctive abrasion patterns associated with differing types of cooking and/or frequency of use (Skibo 2013). Among the Kalinga, vessels used for vegetable and meat cooking exhibited heavier interior rim and neck abrasion as compared to rice cooking pots. The heavy abrasion in the meat/vegetable pots is attributable to the frequent stirring and serving of the vessel contents. For the rice cooking pots, as utensils only came into contact with the vessel during serving.

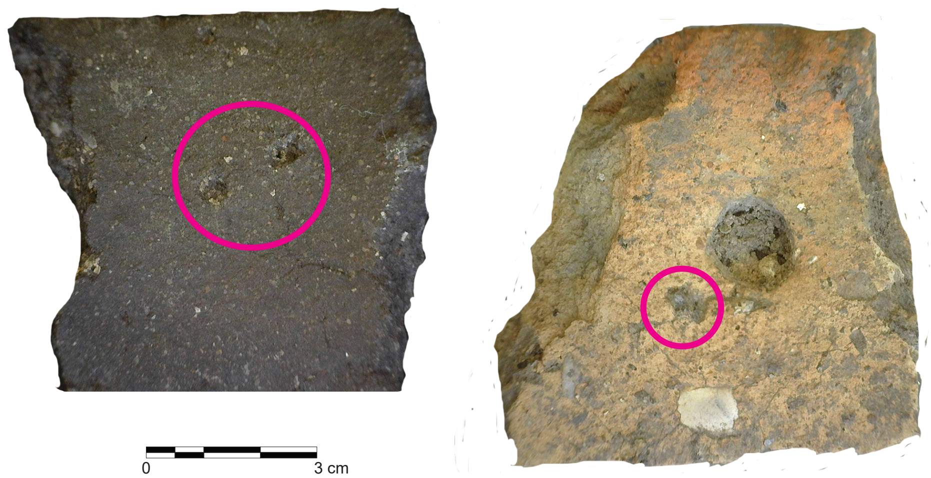


Figure 5.7. Examples of attrition - pitting present in the Early and Middle Woodland vessel assemblage: vessel 3013 (lot 09.089-3601) (left) and vessel 2008 (lot 09.089-0868) (right).

Figure 5.8. Examples of attrition - linear tool present in the Early and Middle Woodland vessel assemblage: vessel 2005 (lot 09.089-2001) (left) and vessel 2040 (lot 09.089-2000).

Two types of attrition patterns are observed and recorded for the Early and Middle Woodland Finch vessel assemblage: linear tool marks and pitting (Figure 5.7, Figure 5.8). The linear tool marks are oriented concentrically (horizontally), radially (vertically), and/or diagonally. The linear marks are likely attributable to long term contact of the vessel wall with a utensil used for stirring, scooping, serving, or scraping (Griffith 1978; Skibo 1992). Pits are shallow, circular cavities in the vessel surface. Each sherd associated with a vessel is examined for evidence of attrition using the naked eye and low magnification (10x). The location of the attrition on the sherd, the sherd type, orientation of the linear abrasion, and /or the surface area of pitting of abrasion are recorded as is a verbal description characterizing the abrasion. Sherds with attrition are photographed using a 10x to 20x digital microscope.

<u>Modeling Culinary Traditions from Functional Analysis</u>

The functional analysis provides insight into culinary traditions by identifying specific cooking related activities that have left distinctive material traces on the ceramic vessels. These activities include hearth design, cooking type, and cooking mode.

Cooking Type: Direct Versus Indirect Heating

Functional analysis of ceramic vessels distinguishes between direct fire boiling and indirect boiling (stone boiling). These two cooking techniques, based on comparative ethnographic data, are widely accepted as having been used by nearly all North American Indian groups (Driver and Massey 1957:229; Sassaman 1991, 1993). Direct fire boiling involves the placement of a vessel (or other type of container) over a heat source (on or suspended over a fire or coals). Indirect heating immerses a previously heated element, typically a stone or a baked clay object, within the liquid contents of a vessel (or container); the vessel is not placed directly on or over the fire or coals (Driver and Massey 1957; Sassaman 1991). Archaeological evidence suggests that indirect cooking techniques, employing low fired pottery, was likely prevalent among most prehistoric hunter and gatherers (Reid 1990; Sassaman 1991). Direct and indirect cooking techniques each offer distinct performance advantages (Skibo 2013). Although both techniques allow for long term simmering, the direct heating requires little oversight while the indirect method requires a high degree of tending and participation (Skibo 2013). Archaeologically, intended function and use-alteration traces (actual function) are used to distinguish between indirect and direct cooking methods (Skibo 2013; Sassaman 1991, 1993).

The presence of exterior sooting indicates that a vessel was placed directly over an open fire or coals during use (Beck et al. 2002; Hally 1983). Typically, the absence of soot evidences that a vessel was not positioned over an open fire (Hally 1983; Sassaman 1993). However, interpreting the absence of soot as evidence for an indirect cooking method or non-cooking use of a pot must consider other variables that would also result in the absence of soot. For example, subsequent use of the vessel for high heat cooking may have burned off all evidence of the soot. The completeness and/or condition of archaeological vessels may also obscure soot patterning. Sooting would not be present on eroded sherds and incomplete vessels may not exhibit sooting due to an uneven distribution pattern (Hally 1983; Sassaman 1993:143).

Direct heating versus indirect heating of vessel contents each demand specific “mechanical performance characteristics” (Sassaman 1991; Skibo 2013) that are reflected in vessel morphology and manufacturing attributes, the intended vessel function. These four mechanical performance criteria consist of: (1) heating effectiveness; (2) vessel content heat loss; (3) thermal shock resistance; and (4) manipulation and removal of contents (Sassaman 1991:158-159, 1993).

Vessels, when used for cooking with a direct, external heat source (flames or coals), are designed to maximize heating effectiveness (thermal conduction), the rate at which the temperature of vessel contents is raised when exposed to heat. Vessels for indirect cooking, in contrast, are manufactured to emphasize insulation, to maintain the temperature when the heating element (such as a heated rock) is added to the vessel contents. Constructing ceramics for thermal conduction versus insulation emphasizes different mechanical attributes relative to vessel shape, wall thickness, and paste composition. Rapid heating and thermal conductivity are facilitated by thin vessel walls and inorganic temper (Braun 1983; Sassaman 1991). Round vessel bases also increase combustion, generating more heat by allowing air flow up and around the vessel bottom and sides (Hally 1986). Vessels manufactured for insulation emphasize thick walls, porous pastes, and flat, thick bottoms to maximize the radiation of the internal heat source (Reid 199; Schiffer and Skibo 1987: 606).

Indirect and direct cooking techniques both require techniques to mitigate vessel content heat loss, the rate at which vessel contents lose heat (Hally 1986:280; Sassaman 1991). Vessels lose heat via radiation from the surface and convection through the orifice. Significant radiation heat loss occurs with permeable vessel walls due to surface evaporation (Schiffer 1988). Decreasing the porosity of the paste and/or applying a coating to the interior of vessels reduces permeability (Rye 1981; Sassaman 1991; Skibo 2013). Vessels intended for indirect heating overcome radiation heat loss through reduced permeability and thick vessel walls (Sassaman 1993:143). Vessels for direct heating also contain features to address radiation heat loss; however, increasing the thickness of walls is an impractical solution as such a trait impairs the transfer or external heat through the ceramic body (Sassaman 1991:160).

For direct-heat vessels, decreasing the size of the orifice reduces convection heat loss. However, overly constricted orifices are poorly suited for boiling as the steam becomes concentrated at the mouth resulting in spill-overs (Linton 1944; Sassaman 1991). For indirect-heat vessels, reduction of convection loss through constriction of the orifice conflicts with the need to manipulate and remove vessel contents, including the heating element (Sassaman 1991).

Thermal shock resistance, the ability of the ceramic body to withstand rapid changes in temperature, is critical for the long term use of direct-heat vessels but less critical for indirect-heat vessels (Sassaman 1991:160). Resistance to thermal shock increases with the uniform vessel wall thickness, round bottoms, simple body contours, and the inclusion of aplastics (Rye 1976:27; Sassaman 1991).

Finally, the ease of vessel content manipulation and removal, although important for direct heat vessels, is critical for indirect-heat vessels (Sassaman 1993:143). With indirect cooking, heating elements are repeatedly cycled from fire to container and vessel contents require manual agitation (stirring) to facilitate even cooking and prevent burning (Sassaman 1991). Vessels used for indirect heating, therefore, tend to be shallow with wide orifices (Reid 1990; Sassaman 1991; Schiffer and Skibo 1987).

Based on characteristics of intended and actual use, the vessels in the Finch assemblage are examined for evidence of direct heating or indirect heating activities (Table 5.4). Presence/absence of exterior sooting on fully intact sherds, taking into consideration the portion of the vessels represented, is recorded for each vessel. Aspects of vessel design are also observed including overall form, orifice type, wall thickness, and paste to further support assessment of use for direct versus indirect heating.

Table 5.4. Modeling Cooking Type from the Ceramic Functional Analysis

Attribute	Direct Heat	Indirect Heat
Actual Use - Use Alteration		
Exterior Sooting	Present	Absent
Intended Use - Vessel Design		
Overall Form	Simple contours, round bottom	Shallow with flat bottom
Orifice	Slightly constricted orifice	Wide orifice
Walls	Thin and uniform walls	Thick walls (insulate)
Paste	Inorganic temper	More porous temper

Note: Adapted from Sassaman 1993:141 and Skibo 2013.

Hearth Design

Presence and patterns of exterior sooting and oxidation discoloration are used to infer the position of vessels in relation to fire during use and the type of heat source (Hally 1983; Skibo 2013). Three types of hearth designs are inferred from exterior sooting patterning: placement on a fire, suspended over a fire, and suspended over coals (Table 5.5; Figure 5.9). The position of sooting on the vessel exterior varies according to the position and proximity of the vessel relative to the heating source (Skibo 2013). When organic material burns, carbonized matter becomes airborne and may adhere to nearby exposed surfaces. As these airborne particles travel upwards, vessels situated on or over fires exhibit sooting in a pattern extending up the vessel profile to the point of the greatest diameter (Hawsey 2015). Sooting may also appear on rims due to skewed placement over a fire or close proximity to flames (Hally 1983). Vessels situated directly on a bed of ash lack sooting on the bottommost portion of vessels as these partially covered areas are minimally exposed to airborne particles emitted during wood combustion (Skibo 2013:92; Hawsey 2015). Vessels suspended over fires tend to exhibit sooting on all portions of the lower vessel exteriors including bases (Skibo 2013). Finally, sooting is infrequent on vessels suspended over coals as coals emit no carbon heavy particles.

Cooking Mode

Ethnographic and experimental studies have associated use-alteration traces with specific cooking activities, effective for distinguishing between cooking modes (Skibo 1992, 2013; Kooiman 2016). In a broad perspective, ethnographic data regarding North American hunter-gatherer cooking methods fall into two general categories: dry mode cooking and wet mode cooking (Reid 1990). Dry mode cooking consists of activities such as broiling, roasting, baking, and parching. Wet cooking methods reference a variety of simmering, boiling, and steaming tasks.

Based on a review of northwestern North American hunter-gatherer cooking technologies, the primary function of container-based moist cooking was to render oil from seeds and nuts, or grease from meat and bone. Simmering provides the ideal temperature (85 to 88° C) for reducing

Table 5.5. Modeling Hearth Design - Direct Cooking from the Ceramic Functional Analysis

Description	Exterior Soot Patterning
Pots Placed in Fire	Sooting on body but absent at base and rim
Pots Suspended over Fire	Sooting on body and base but absent at rim
Pots Suspended over Coals	Limited sooting

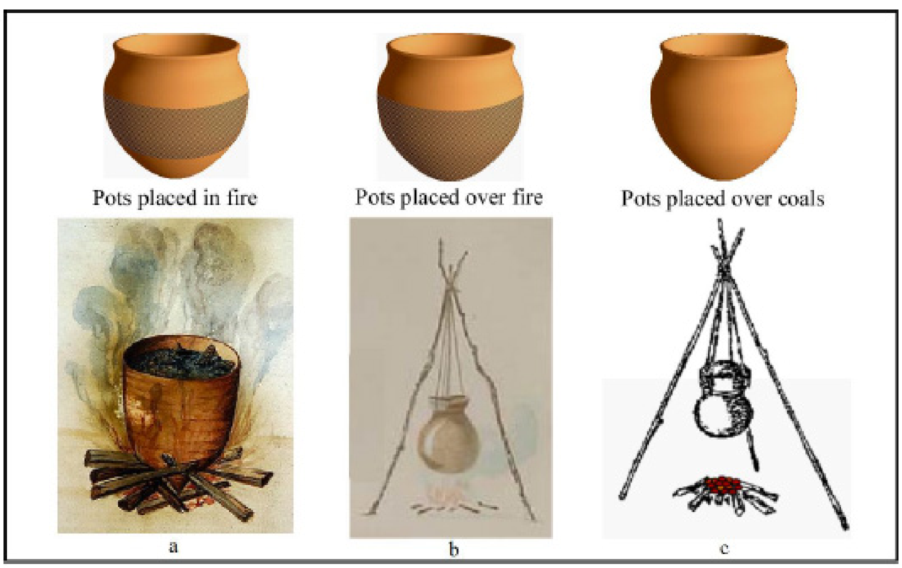


Figure 5.9. Exterior carbonization patterns and hearth design (after Hawsey 2015: Figure 15): (a) Lorant 1946; (b) Eastman watercolor 1847; (c) Wilbur 1996.

connective tissue or collagen to a gel; Boiling temperatures (≥100° C) result in the coagulation of the protein, toughening and shrinking the product (Reid 1990; Sassaman 1991). Boiling is also not conducive for oil or fat rendering, as the turbulent water surface inhibits the skimming off of the desired oils and fats (Leechman 1951; Reed 1988; Sassaman 1991). Sustained boiling, however, is an effective technique for certain types of foods made palatable only through such activities, including domesticated starchy seeds, legumes, and maize (Sassaman 1991).

Patterns of interior sooting, and to more limited extent, exterior soot, have proven useful for distinguishing between wet and dry mode cooking, as well as honing in on specific types of wet mode cooking (such as boiling, simmering or stewing) (Kooiman 2016; Skibo 2013).

The classic indicator of wet mode cooking is the presence of a band or ring of carbonization ("scum line") within the interior of the vessel that marks the water line and reflects habitual boiling/simmering tasks. Below the water line, vessel wall temperatures typically do not exceed 100°C, as the water seeps through the vessel walls and evaporates, cooling the vessel surface (Skibo 2013). Above the water line, carbonization occurs once the vessel walls reach temperatures between 300° C to 400° C (Skibo 2013). Carbonization may also appear on other portions of the vessel interior during boiling. Water containing organic material may be absorbed into the vessel walls and then burned during subsequent heating episodes (Banducci 2014; Skibo 1992, 2013). Vessels placed directly over a fire or bed of charcoal may exhibit carbonization along the interior base of the pot, caused by the vessel drying out, allowing the foodstuffs to char (Banducci 2014).

Recent ethnoarchaeological and archaeological research has discerned use-alteration traces particular to certain types of wet-mode cooking. Based on the Kalinga ethnoarchaeological study, Skibo (2013) notes that boiling activities tend to produce lighter deposits of soot as compared to simmering. Simmering with little water results in heavy interior vessel soot deposits concentrated in the middle portion of the vessel and on the base (Skibo 2013).

Using archaeological data from Michigan's Upper Peninsula, Kooiman (2016) differentiated between vessels used for boiling/simmering activities and stewing using the positioning of the water line and the presence/absence of carbonization above the line (Kooiman 2016). Vessels exhibiting a solid band of carbonization from the top of the vessel to the lower rim area, with a distinct scum line, were interpreted as representing habitual boiling activities. Vessels used for stewing, although a scum line is present along the interior rim, lacked a solid band of carbonization from the scum line to the top of the vessel (Kooiman 2016).

In dry mode cooking, such as broiling, roasting, baking, and parching, much of the interior of the vessels exhibits carbonization. With the absence of water, vessel walls in dry mode cooking can reach 300° to 400° C allowing for foodstuffs to char and adhere to the vessel surface.

As noted above, the presence of exterior soot provides direct evidence of vessel use in a fire or directly over a heat source. The patterning of exterior soot can further be used to infer cooking mode. For wet mode cooking over a fire or coals, exterior sooting occurs as a resin or oxidized patch on the base and body of the vessel. In particular, simmering and/or boiling produce heavy deposits of soot on the middle vessel portion. For dry mode cooking over a fire or coals, oxidized patches on the base are common as the vessel surface can reach very high temperatures (Skibo 2013).

Based on the above discussion, patterning of interior and exterior carbonization distinguishes between wet mode and dry mode cooking, as well as between various type so of wet mode cooking. The interior and exterior patterning is summarized in Table 5.6 for each type of cooking mode.

Chemical Residue Analysis

Chemical residue analyses, using fatty acids extracted from ceramic vessel walls, is performed on a sample of the vessels to identify vessel contents, further elucidating actual use. Fatty acids reveal specific plant and animal types and are resistant to depositional degradation and contamination

(Skibo 2013, 2015). Chemical residue analysis involves the extraction of lipids from the ceramic fabric (a destructive process) and the identification of residues using a number of techniques, including fatty acid composition, biomarkers, and triacylglycerols (TAGs) (Malainey and Figol 2017). These techniques differentiate between plant and animal residues, as well as identifying specific plant and animal profiles.

Identification of residues provides unequivocal evidence of the preparation of specific foods within vessels (Anderson et al. 2017; Craig et al. 2011; Evershed 2008a, 2008b; Hansel et al. 2011; Reber et al. 2010; Reber and Evershed 2006; Skibo et al. 2016). Fatty acids preserved in ceramic vessel walls have been successfully used to identify contents and to map changes in subsistence elsewhere in the Great Lakes region, including domesticated plant use histories (Crowther 2012; Goette et al. 1994; Hart et al. 2003, 2012; Hart 2014; King et al. 1987; Malainey 2007; Malainey et al. 1999, 2001; Myers 2006; Reber and Evershed 2006; Simon 2017; Skibo 2015; Thompson et al. 1994; Wright 2010). Using multiple lines of evidence for the identification of foodways is

Table 5.6. Modeling Cooking Type from the Ceramic Functional Analysis

Description	Interior Carbonization	Exterior Soot Patterning
Wet Mode: Boiling	Scum/Water line; Patches on mid-vessel and/or base. Lighter soot deposits than simmering. Solid band from scum/line to top of vessel.	Direct: Heavy soot on mid-body and base Indirect: Absent
Wet Mode: Simmering	Scum/Water line; Heavy mid-vessel deposits; Patches on base. Heavier soot deposits than boiling. Solid band from scum/line to top of vessel.	Direct: Heavy soot on mid-body and base Indirect: Absent
Wet Mode: Stewing	Scum/Water line present but lack of solid band to top of vessel.	Direct: Soot present Indirect: Absent
Dry Mode	Heavy sooting throughout interior	Direct: Soot present, oxidized patches at base Indirect: Absent

a critical component of this study as taphonomic processes and recovery techniques affect the types of plant and animal remains recovered archaeologically (Grayson 1973, 1984; Hastorf 1999; Shaffer and Sanchez 1994; Stahl 2011; Wright 2010). The chemical residue analysis represents a crucial data source given its potential to identify biomarkers that may not be typically preserved in plant macroremains and the zooarchaeological assemblage due to taphonomic processes and/or recovery techniques.

Fatty acids are the major constituents of fats and oils (lipids) that occur in nature as triglycerides (three fatty acids attached to a glycerol molecule by ester-linkages). Their insolubility in water and relative abundance compared to other classes of lipids, such as sterols and waxes, make fatty acids suitable for residue analysis. Following Skibo (2013, 2015), analysis of fatty acids for chemical residue studies is preferred based on the ability to link fatty acids to specific plant and animal types as well as the resistance of fatty acids to depositional degradation and contamination (Skibo 2013, 2015).

Samples from 13 vessels are used for the analysis of fatty acids. Samples were submitted to Dr. Mary Malainey at Brandon University (Appendix H, Appendix I, Appendix J). The sherds are from the upper body/neck or the mid- to low- body portions of the Early and Middle Woodland vessels.

Chemical residue analysis is a two step process that involves the extraction of lipids from the ceramic fabric (a destructive process) and the identification of residues. Exterior ceramic surfaces are ground off to remove any contaminants. Samples are crushed and absorbed lipid residues are extracted with organic solvents. Lipid extracts are analyzed using gas chromatography (GC), high temperature GC (HT-GC) and high temperature gas chromatography with mass spectrometry (HT-GC/MS). Three methods are used to identify the chemical residues, consisting of fatty acid composition, biomarkers, and triacylglycerols (TAGs) (Malainey and Figol 2017, 2019).

Based on experimental residues, the levels of medium chain fatty acids (C12:0, C14:0 and C15:0) and C18:0 and C18:1 isomers in the sample distinguish between large herbivore, large herbivore with plant or bone marrow, low fat content plant (plant greens, roots, berries), medium-low fat content plant, medium fat content (fish/corn), moderate high fat content (beaver), high fat content (high fat nuts and seeds), freshly rendered animal fat other than large herbivore, and very high fat content (very high fat nuts and seeds, freshly rendered fat other than large herbivore) (Malainey 1997, Malainey et al. 1999b, Malainey et al. 1999c, 2001b). Higher levels of medium chain fatty acids, combined with low levels of C18:0 and C18:1 isomers, are associated with decomposed experimental residues of plants, such as roots, greens and most berries. High levels of C18:0 are indicative of large herbivores. Moderate levels of C18:1 isomers, with low levels of C18:0, correlates with the presence of either fish or foods similar in composition to corn. High levels of C18:1 isomers with low levels of C18:0, are found in residues of beaver or foods of similar fatty acid composition (Malainey 1997; Malainey et al. 1999c; 2001b).

Biomarkers distinguish between animal-derived and plant-derived residues (Evershed et al. 1990). Triacylglyercols, diacylglycerols, and sterols are identifiers for animal residue as animals contain cholesterol and significant levels of triacylglycerols. Plant-derived residues are indicated by plant sterols, such as B-sitosterol, stigmasterol and campesterol, with only traces of triacylglycerols (Evershed 1993; Evershed et al. 1997a; Dudd and Evershed 1998).

Lastly, TAGs discern between animal and plant residues, as well as oil seeds (Malainey et al. 2014). When present, amounts of TAGs tend to decrease with increasing numbers of carbon atoms in plant residues (Malainey et al. 2014). In animal residues, amounts of TAGs tend to increase with carbon numbers, with the C52 or C54 TAG peaks being the largest (Malainey et al. 2014). A parabola-like pattern, such as the shape of a “normal distribution,” also occurs in the residues of oily seeds that contain high levels of C18:1 isomers (Malainey et al. 2014).

Statistical Analysis Measures

Several statistical measures are employed to identify and define quantitative patterns in the ceramic data set. Simple statistics quantify the ceramic data sets, using counts and weights, as well as standard descriptive measures. Range and mean characterize the data and relative frequencies standardize the data set to allow for comparisons between groups of data. Relative frequencies, using the vessel as the unit of analysis, compare patterning of various attributes between the Early and Middle Woodland vessel assemblages.

Quantitative data is summarized using box plots, a powerful and intuitive graphical method for conveying differences between samples, periods, or sites (Cleveland 1994; Marston 2014; McGill et al. 1978; Scarry 1986; Scarry and Steponaitis 1997; Wilkinson et al. 1992; VanDerwarker 2003). Box plots are based on simple descriptive statistics that represent sample medians, typically indicated by a line or notch, and the dispersion of values around that median, through box edges and whiskers. The edges of the box (hinges) represent the 25th and the 75th percentiles of the distribution. The approximate middle 50 percent of the data fall between the hinges. Box plots also designate outliers, those samples that have unusually large or small data values. Outliers are depicted as circles and far outliers as asterisks. Box plots are displayed using standardized scores (z-scores).

Several statistical tests examine the relationship and significance between samples including a t-test, Kruskal-Wallis, and Pearson's correlation coefficient. The t-test is a parametric test, requiring the assumption that the samples are normally distributed. A one sample t-test compares the average of a sample to a reference value. The t-test is used when the true variance of the population from which the sample has been extracted is unknown. The Kruskal-Wallis test is a non-parametric test to determine whether samples originate from the same distribution. The test is appropriate for independent samples of equal or different sizes and does not assume a normal distribution of the residuals. Pearson's correlation coefficient (Pearson's r) tests the association between two quantitative variables.

Multivariate statistics discover structure or patterning within a data set, highlight relationships between samples (and species for plant and animal remains), summarize and succinctly present large data sets, reduce noise within the data and identify outliers, and/or classify or group samples based on their contents (Gausch 1982; Smith 2014:182). Multivariate statistics used in this study include cluster analysis and correspondence analysis; both are indirect approaches that allow for a more open ended exploration of the data set and do not presume that the variables affecting the data are known (Smith 2014:182).

A k-means cluster analysis is a data reduction technique that uses an algorithm to find groups in the data, with the number of groups represented by the variable K. The algorithm works iteratively to assign each data point to one of K groups based on the features that are provided. The solution is not necessarily the same for all starting points so that the calculations are repeated several times in order to reach the optimal solution.

Correspondence analysis is a descriptive, exploratory, unconstrained/open-ended technique that is designed to arrange samples based on their composition without assuming any prior knowledge of the variables affecting the composition and is a valuable tool for the interpretation of complex datasets (Baxter 1994; Gausch 1982; Shennan 1997; Smith 2014; ter Braak 1995:116-132). As a type of indirect gradient ordination analysis that employs weighted averaging and a chi-square statistic, correspondence analysis is appropriate for nominal data (Lepš and Šmilauer 2003:37; Shennan 1997; VanDerwarker et al. 2014:211). Correspondence analysis displays the rows and columns of a contingency table in graphical form, reducing the dimensionality of the data and exploration of variability (Alberti 2013). The technique reduces the number of dimensions needed to display the data point by decomposing the total inertia (variability) of the table and defining the smallest number of dimensions capable of capturing the data variability (Alberti 2013:481).

Correspondence analysis provides a scatter plot in Euclidean distance illuminating patterns in numerical data that reflect relationships between cases and variables (Kujit and Goodale 2009). The graphical output of a scatterplot represents rows and columns as points on a sequence of two dimensional spaces. The spaces have the properties to retain a decreasing amount of the total inertia (Alberti 2013). The first dimension will capture the highest amount while the second will be associated with the second largest proportion, and so on (Alberti 2013). On the scatterplot, the distance between data points of the same type (i.e. row to row) is related to the degree to which the rows have similar profiles (i.e. relative frequencies of column categories). The same applies to column to column distance. The more the points are close to one another, the more similar their profiles will be. The origin of the axes represents the centroid (average profile) and can be conceptualized as the place where there is no difference between profiles, or, more formally, it represents the hypothesis of homogeneity of the profiles (Alberti 2013; Greenacre 2007). The more different are the latter, the more the profile points will be spread on the plane away from the centroid. Although it is only possible to observe two dimensions at any time within a biplot, by examining multiple biplots, multidimensional space can be considered (Smith 2014).

Results of the Attribute Analysis

The results of the attribute analysis for the Early and Middle Woodland vessel assemblage are detailed below. Vessel morphology, manufacture, and decoration are described for the assemblage as a whole. Temporal patterns, examining the occurrence of vessel attributes associated with the Early and Middle Woodland vessels are delineated. Key points of similarity and dissimilarity of attributes between the Early and Middle Woodland vessel assemblage are also elucidated.

Vessel Morphology

Attributes pertaining to vessel morphology consist of vessel form, rim form, lip form, vessel diameter and size, and wall thickness.

Vessel Form

All of the Early and Middle Woodland vessels are jars. Jar forms represented in the assemblage include conoidal, sub-conoidal, globular, and tecomate (neckless jar) varieties (Table 5.7). Conoidal, sub-conoidal, and globular forms are present in both the Early and Middle Woodland assemblages. The seed jar/tecomate type is only present in the Middle Woodland assemblage. A larger percentage of the Early Woodland vessels, as compared to the Middle Woodland assemblage, are not classifiable by jar form type due to a lack of completeness that prohibits an accurate assessment of geometric shape.

Most Early Woodland jars are globular or conoidal. Only two Early Woodland jars have a sub-conoidal shape (Table 5.7). The majority of Middle Woodland jars have a conoidal form, followed in frequency by globular jars. Sub-conoidal and tecomate/seed jar forms are each represented by a single Middle Woodland vessel.

Comparatively, Early Woodland globular jar forms have a higher relative frequency than the Middle Woodland assemblage. Conoidal jar forms, although common in both Early and Middle Woodland assemblages, are the dominant form of the Middle Woodland jars. Sub-conoidal jars occur in low frequencies in both Early and Middle Woodland assemblages. As noted above, the tecomate jar form is only present in the Middle Woodland assemblage.

Table 5.7. Early and Middle Woodland Vessel Morphology: Jar Form

Jar Form	Early Woodland Vessels		Middle Woodland Vessels		Total	
	Number	Percent	Number	Percent	Number	Percent
Conoidal	6	22.22	37	82.22	43	59.72
Sub-conoidal	2	7.41	1	2.22	3	4.17
Globular	7	25.92	6	13.33	13	18.05
Tecomate	0	0.00	1	2.22	1	1.39
Indeterminate	12	44.44	0	0.00	12	16.67
Total	27	100.00	45	100.00	72	100.00

Rim Form

Rim stances represented in the Early and Middle Woodland vessel assemblage consist of direct, slightly everted, everted, slightly inverted, and inverted (Table 5.8). Nearly half of the vessels exhibit direct rims with remaining vessels having rim stances relatively evenly split among the slightly everted, everted, and slightly inverted categories. Only one vessel has an inverted rim stance, the Middle Woodland tecomate/seed jar.

Early Woodland rim stances include direct, slightly everted, and everted forms. Slightly inverted and inverted rim stances are not represented in the Early Woodland vessel assemblage. By frequency, most Early Woodland vessels, fully 59.3 percent, exhibit direct rims. Slightly everted rims are present on 25.9 percent, and everted rims on 14.8 percent, of the Early Woodland vessels.

Rim stances of the Middle Woodland vessels consist of direct, slightly everted, everted, slightly inverted, and inverted forms. Just under half, fully 44.4 percent, of the Middle Woodland vessels exhibit direct rims. Vessels with slightly inverted rims follow in frequency, present on 22.2 percent of the Middle Woodland vessels. Middle Woodland vessels with slightly everted and everted rims are equally represented in the assemblage, each totaling 15.6 percent. Inverted rim stances are least represented in the Middle Woodland assemblage, occurring on a single vessel.

Table 5.8. Early and Middle Woodland Vessel Morphology: Rim Stance

	Early Woodland Vessels		Middle Woodland Vessels		Total	
Rim Stance	Number	Percent	Number	Percent	Number	Percent
Direct	16	59.26	20	44.44	36	50.00
Slightly Everted	7	25.93	7	15.56	14	19.44
Everted	4	14.81	7	15.56	11	15.28
Slightly Inverted	0	0.00	10	22.22	10	15.28
Inverted	0	0.00	1	2.22	1	1.39
Total	27	100.00	45	100.00	72	100.00

Rim shapes represented in the Early and Middle Woodland vessel assemblages consist of pinched, thickened, thickened and folded, folded, and unmodified (Table 5.9). Unmodified rims occur most frequently in the assemblage, followed in frequency by folded rims, and pinched rims. Least represented in the Early and Middle Woodland vessel assemblage are thickened and thickened and folded rims.

Each rim form type is represented in the Early Woodland vessel assemblage. Unmodified rims are the most frequent, occurring on 37.0 percent of the Early Woodland vessels. Pinched rims follow in frequency, present on 29.6 percent of the Early Woodland vessels. Folded rims, thickened rim, and thickened and folded rims occur on 14.8 percent, 11.1 percent, and 7.4 percent, respectively of the Early Woodland vessels.

The Middle Woodland vessel assemblage rim shapes include only three forms: pinched, folded, and unmodified. Most of the Middle Woodland vessels, fully 44.4 percent, have an unmodified rim form. Folded rims follow in frequency, occurring on 42.2 percent of the vessels. Least represented are pinched rims that are present on 13.3 percent of the Middle Woodland vessels.

Lip Form

Lip form of the Early and Middle Woodland vessels consist of flattened, rounded, and beveled types (Table 5.10). Two-thirds of the vessels exhibit flattened lips. Rounded lips follow in frequency and beveled lips are least represented in the vessel assemblage. All three lip form types are present in both the Early and Middle Woodland vessel assemblages. Relative frequencies by lip form type exhibit similar frequencies in both the Early and Middle Woodland vessel assemblages. The majority of Early Woodland vessels, fully 62.9 percent, exhibit flattened lips. Rounded lips occur on 33.3 percent of the Early Woodland vessels. Beveled lips occur on a single Early Woodland vessel. The majority of Middle Woodland vessels, fully 68.9 percent, have flattened lips. Rounded lips occur on 24.4 percent of the vessels and beveled lips are present on 6.7 percent of the Middle Woodland vessels.

Table 5.9. Early and Middle Woodland Vessel Morphology: Rim Shape

Rim Shape	Early Woodland		Middle Woodland		Total	
	Number	Percent	Number	Percent	Number	Percent
Pinched	8	29.63	6	13.33	14	19.44
Thickened	3	11.11	0	0.00	3	4.17
Thickened & Folded	2	7.41	0	0.00	2	2.78
Folded	4	14.81	19	42.22	23	31.94
Unmodified	10	37.04	20	44.44	30	41.67
Total	27	100.00	45	100.00	72	100.00

Table 5.10. Early and Middle Woodland Vessel Morphology: Lip Form

Lip Form	Early Woodland		Middle Woodland		Total	
	Number	Percent	Number	Percent	Number	Percent
Flattened	17	62.96	31	68.89	48	66.67
Beveled	1	3.70	3	6.67	4	5.56
Rounded	9	33.33	11	24.44	20	27.78
Total	27	100.00	45	100.00	72	100.00

Vessel Diameter

Vessel diameter at the rim is used to approximate the size (or capacity) of the jars (Blitz 1993; Kooiman 2016; Shapiro 1994). The uniformity of Woodland vessels forms and previous studies confirms the validity of relationship between vessel rim radius and vessel size (Kooiman 2012; Fitting and Halsey 1966; Shapiro 1994; Blitz 1993). Orifice diameter is estimated for those vessels with at least five percent of the vessel rim circumference present. A total of 52 vessels have measurable rim diameters including 18 Early Woodland vessels and 34 Middle Woodland vessels (Table 5.11). For the Early and Middle Woodland vessels, orifice diameters range from 10 to 46 cm, with an average diameter of 21.08 cm. Early Woodland vessels exhibit orifice diameters ranging from 10 to 30 cm and averaging 18.33 cm. Orifice diameters of Middle Woodland vessels range from 10 to 46 cm with an average 22.53 cm.

Two techniques compare Early and Middle Woodland vessels sizes. The first method classifies the vessels into four categories through cluster analysis and then compares the relative frequencies of each size category. The second method uses notched box plots and a Kruskal-Wallis test to assess for statistically significant differences between the Early and Middle Woodland vessel populations based on orifice diameter.

Based on orifice diameter, the Early and Middle Woodland vessels are classified into four size categories, small, small-medium, medium-large, and large, using a *k*-means cluster analysis (Rogerson 2010) (Table 5.12). The cluster analysis, a data reduction technique, groups together similar observations. The *k*-means cluster analysis is conducted using the standardized *z*-scores of the vessel diameters. Convergence was achieved after two iterations. The range and mean associated with each size category is provided in Table 5.12.

For both the Early and Middle Woodland vessel assemblage, most vessels fall into the small-medium size range (Table 5.12; Table 5.13). Small sized and medium-large vessels follow in frequency. Least represented in the overall vessel assemblage are large vessels.

Table 5.11. Early and Middle Woodland Vessel Morphology: Orifice Diameter

Vessel Type	Number	Average (cm)	Range (cm)
Early Woodland	18	18.33	10-30
Middle Woodland	34	22.53	10-46
Total	52	21.08	10-46

Table 5.12. Early and Middle Woodland Vessel Size Categories

Size Category	Number	Range Low (cm)	Range High (cm)	Mean (cm)
Small	13	10	14	11.23
Small-Medium	25	16	22	19.04
Medium-Large	10	28	32	30
Large	4	40	46	43.5

Table 5.13. Early and Middle Woodland Vessel Morphology: Vessel Size Classification

Size	Early Woodland		Middle Woodland		Total	
Classification	Number	Percent	Number	Percent	Number	Percent
Small	5	27.78	8	23.53	13	25.00
Small - Medium	10	55.56	15	44.12	25	48.08
Medium-Large	3	16.67	7	20.59	10	19.23
Large	--	--	4	11.76	4	7.69
Total	18	100.00	34	100.00	52	100.00

Early Woodland vessel sizes consist of small, small-medium, and medium-large; no vessels classified as large are present in the Early Woodland vessel assemblage (Table 5.13). By relative frequency, most Early Woodland vessels, fully 55.6 percent, are small-medium sized. Small vessels compose 27.8 percent of the Early Woodland vessels. The least represented size category for the Early Woodland vessels are medium-large vessels, representing 16.7 percent of the assemblage.

All size categories are represented in the Middle Woodland assemblage. Small-medium Middle Woodland vessels exhibit the highest frequency of occurrence at 44.1 percent. Small and medium-large vessels follow in frequency, representing 23.5 percent and 20.6 percent of the Middle Woodland vessel assemblage, respectively. Large vessels have the lowest frequency, accounting for 11.8 percent of the Middle Woodland vessels.

The notched box plots, comparing the standardized scores of the Early and Middle Woodland vessel diameters, visually express the greater range of size variation of the Middle Woodland vessels (Figure 5.10). The notches on the boxplots, where the boxplot is constricted like an hourglass, define the 95 percent confidence interval around the median. As the notches for the Early and Middle Woodland orifice diameters ratios overlap, the samples are not significantly different at the 0.05 confidence level. Moreover, a Kruskal-Wallis two-tailed tests produces a *p-value* of 0.135, indicating that the Early and Middle Woodland vessels are derived from the same population (Table 5.14). The Kruskal-Wallis test uses the raw scores and z-scores of the vessel diameters.

Wall Thickness

Vessel wall thickness is calculated for all of the vessels with the exception of one vessel that is too exfoliated to obtain a measurement. Thicknesses of Early and Middle Woodland vessels range from 4.04 to 13.26 mm with an average of 8.21 mm (Table 5.15). Early Woodland vessels range from 4.04 mm to 13.26 mm with an average of 7.72 mm. Middle Woodland vessel thicknesses

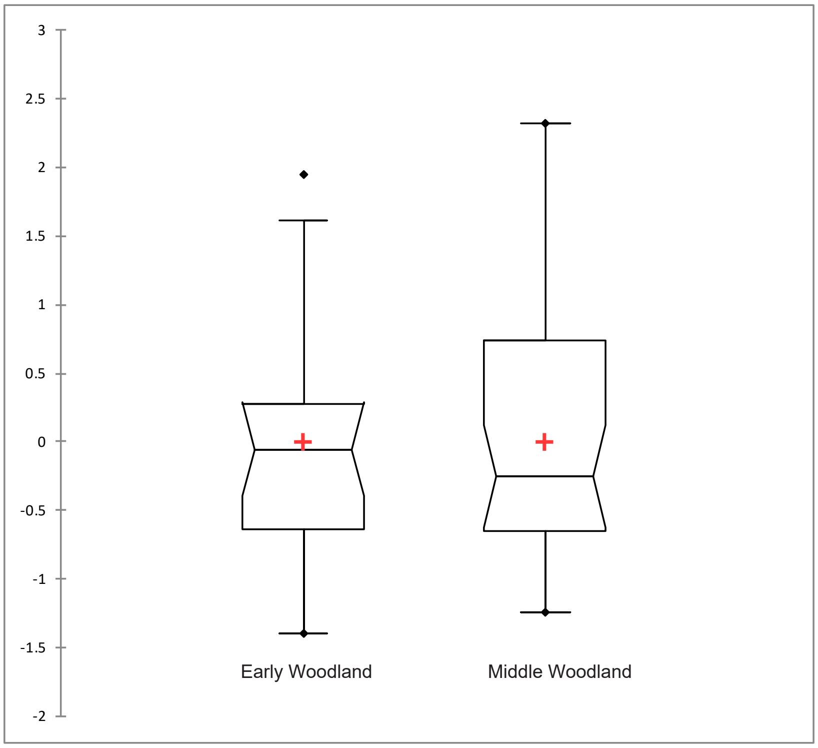


Figure 5.10. Box plots comparing Early and Middle Woodland vessel orifice diameters. Raw data included as Appendix E.

Table 5.14. Kruskal-Wallis Test of Early and Middle Woodland Vessel Orifice Diameters

Description	Value
K (Observed value)	2.232
K (Critical value)	3.841
DF	1
p-value (one-tailed)	0.135
alpha	0.05

Note: Raw data included as Appendix E.

range from 6.17 to 11.47 mm, averaging 8.51 mm. Middle Woodland vessels have a narrower range and higher average thickness than Early Woodland vessels.

Vessel walls are classified as thin or thick using a *k*-means cluster analysis (Table 5.16). The *k*-means cluster analysis is conducted on the standardized z-scores of the vessel wall thickness. Convergence was achieved after six iterations. Observations of wall thickness are recorded for 71 vessels; one vessel is too eroded to allow for an accurate thickness measurement. The *k*-means cluster analysis classifies thin walled vessels as ranging from 4.04 to 7.95 mm, averaging 6.84 mm. Thick walled vessels range from 8.22 mm to 13.26 mm, averaging 9.4 mm. By component, most (55.6 percent) Early Woodland vessels are thin-walled. The Middle Woodland component has a higher frequency (59.1 percent) of thick walled vessels than thin-walled vessels.

A two sample t-test determines if there is a statistically significant difference between the thickness of Early and Middle Woodland vessels (Table 5.17). A two sample t-test examines whether or not the mean thickness of the Early Woodland vessels is equal to the mean thickness of Middle Woodland vessels. Levene's test, based on a F-statistic, yields a *p-value* of 0.08, indicating that the variances of the Early and Middle Woodland vessel thicknesses are equal. Based on equal variances, the results of the t-test produces a *p-value* of 0.05, indicating that the null hypothesis is rejected, and that mean thickness of Early and Middle Woodland vessels are significantly different at the 95 percent confidence level. The Middle Woodland vessels have thicker vessel walls than the Early Woodland containers.

As noted by Picard and Haas (2019), the Early Woodland Prairie ware vessels had exceptionally thin vessel walls that could possibly skew the data. The t-test was run a second time omitting the four Prairie ware vessels (Table 5.18). The Early Woodland vessels, without the Prairie ware vessels, continue to exhibit an average thinner vessel wall thickness than the Middle Woodland vessels. The t-test, however, yielded a *p-value* of 0.250, indicating that, based on wall thickness, Early and Middle Wood vessel do not exhibit statistically significant differences.

Table 5.15. Early and Middle Woodland Vessel Morphology: Vessel Thickness

Component	Number	Average (mm)	Range (mm)
Early Woodland	27	7.72	4.04 to 13.26
Middle Woodland	44	8.51	6.17 to 11.47
Total	71	8.21	4.04 to 13.26

Table 5.16. Vessel Wall Thickness: *k*-means Cluster Analysis

			Early Woodland		Middle Woodland		Total	
Vessel Wall	Range	Mean	Number	Percent	Number	Percent	Number	Percent
Thin-Wall	4.04 - 7.95	6.84	15	55.56	18	40.91	33	46.48
Thick-Wall	8.22 - 13.26	9.4	12	44.44	26	59.09	38	53.52
Total	4.04 - 13.26	8.21	27	100.00	44	100.00	71	100.00

Table 5.17. Two-Sample T-Test of Vessel Thickness Comparing the Early and Middle Woodland Vessels

Data			t-Test Results				
Component	Number	Mean	Levene's Test		Equal Variances Assumed		
Early Woodland	27	7.72	F-Statistic	Significance	t	df	Significance (2-tailed)
Middle Woodland	44	8.51	3.09	0.08	-2.026	69	0.05

Table 5.18. Two-Sample T-Test of Vessel Thickness Comparing the Early and Middle Woodland Vessels Omitting Prairie Ware

Data			t-Test Results				
Component	Number	Mean	Levene's Test		Equal Variances Assumed		
Early Woodland	23	8.06	F-Statistic	Significance	t	df	Significance (2-tailed)
Middle Woodland	44	8.51	1.345	0.250	-1.171	65	0.25

As vessel thickness is often affected by vessel size (Hart et al. 2012), the relationship between vessel thickness and vessel size, based on orifice diameter, is explored using two metrics. The first method controls for vessel size by dividing the thickness by diameter (Hart et al. 2012). A subset of the Early and Middle Woodland vessels are used that have measurable rim diameters. The *thickness : diameter* ratio indicates a slight thinning of vessel walls from Early Woodland to Middle Woodland (Table 5.19). Note also that the subset of vessels indicate that Middle Woodland vessels are slightly thinner than Early Woodland, suggesting sampling effects. The second method evaluates the significance of the relationship between vessel size and thickness through a Pearson's r correlation coefficient. This test uses the 52 vessels that have measurable vessel orifice diameters. The Pearson's r produces a correlation coefficient of 0.169 indicating a slight positive correlation between thickness and vessel size (Table 5.20). However, the p-value is 0.230 indicating that this is not a statistically significant relationship. Collectively, the variety of data analytical techniques indicate that Middle Woodland vessels, on average, are thicker than Early Woodland vessels. However, the increase in thickness is related, to a certain extent, to the size of the vessel. The increase in vessel thickness of IOCM wares as compared to Havana wares is consistent with Braun's (1987; 1991) findings that Liverpool wares have thinner walls on average than Havana wares.

Vessel Manufacture

Attributes relating to vessel manufacture include temper type, paste characterization and composition, oxidation patterns, and surface treatment.

Temper

With the exception of four sand-tempered Early Woodland vessels, all of the Early and Middle Woodland vessels are grit tempered (Table 5.21). The grit temper is further characterized by the presence of other mineral and rock inclusions. Most grit-tempered vessels have temper composed of only crushed granitic grit, however, some vessels also contain feldspar, pebbles, and/or mafic rock along with the granitic grit. The Early Woodland grit-tempered vessels contain crushed granite as

Table 5.19. Ratio of Vessel Thickness to Rim Diameter

Description	Number of Vessels	Average Thickness (mm)	Average Rim Diameter (mm)	Ratio Thickness: Rim Diameter
Early Woodland	18	8.43	18.33	0.46
Middle Woodland	34	8.36	22.53	0.37

Table 5.20. Pearson's r Correlation Coefficient for Vessel Thickness and Vessel Orifice Diameter

Correlation Matrix		
Variables	Thickness	Orifice Diameter
Thickness	1	0.169
Orifice Diameter	0.169	1
p-values (Pearson)		
Variables	Thickness	Orifice Diameter
Thickness	0	0.230
Orifice Diameter	0.230	0

well as crushed granite combined with feldspar and pebbles. None of the Early Woodland vessels have mafic rock inclusions in the temper. The Middle Woodland vessels have temper composed of crushed granite as well as crushed granite combined with feldspar, pebbles, and mafic rock. Higher frequencies of crushed granitic temper with feldspar and with pebbles occur in the Middle Woodland vessels as compared to the Early Woodland vessels. The occurrence of rounded pebbles in Middle Woodland vessels is noted by Salzer (n.d.) for the Highsmith and Cooper's Shores sites.

Paste

Early and Middle Woodland vessels have paste types characterized as friable, compact, and very compact (Table 5.22). One-half of the vessels have compact pastes. Friable pastes follow in frequency and least represented are vessels with very compact pastes. All three varieties are associated with each component. Nearly 60 percent of the Early Woodland vessels have compact pastes. Based on relative frequencies, most Early Woodland vessels exhibit a compact paste, followed by vessels with friable paste; very compact paste is present on only one Early Woodland vessel. The frequency distribution of paste compactness observed on Middle Woodland vessels is similar to the Early Woodland pattern. Most Middle Woodland vessels have an compact paste, some have friable paste, and few have a very compact paste.

Oxidation

Oxidation patterns are classified into seven types based on interior/exterior surface characteristics and the paste core color (Table 5.23). Most vessels are fully oxidized. Fully reduced vessels, uneven oxidation patterns, and vessels with oxidized exteriors/reduced interiors follow in frequency. Least represented in the assemblage are vessels with reduced exteriors/oxidized interiors, reduced exteriors/interiors with an oxidized core, and oxidized exterior surfaces with a reduced core. All oxidization types are present in both the Early and Middle Woodland assemblage. The Early and Middle Woodland assemblage both have fully oxidized (OX1), fully reduced (OX2), and uneven patterns (OX7) as the dominant types.

Table 5.21. Early and Middle Woodland Vessel Manufacture: Macroscopic Temper Composition

Temper Types	Early Woodland		Middle Woodland		Total	
	Number	Percent	Number	Percent	Number	Percent
Crushed granite	20	74.07	23	51.11	43	59.72
Granite/feldspar	2	7.41	10	22.22	12	16.67
Granite/pebbles	1	3.70	10	22.22	11	15.28
Granite/mafic rock	--	--	2	4.44	2	2.78
Sand	4	14.81	0	0.00	4	5.56
Total	27	100.00	45	100.00	72	100.00

Table 5.22. Early and Middle Woodland Vessel Manufacture: Paste Compactness

Paste Types	Early Woodland		Middle Woodland		Total	
	Number	Percent	Number	Percent	Number	Percent
Friable	10	37.04	20	44.44	30	41.67
Compact	16	59.26	20	44.44	36	50.00
Very Compact	1	3.70	5	11.11	6	8.33
Total	27	100.00	45	100.00	72	100.00

Table 5.23. Early and Middle Woodland Vessel Manufacture: Oxidation Patterns

Oxidation Pattern	Early Woodland		Middle Woodland		Total	
	Number	Percent	Number	Percent	Number	Percent
OX1 - Fully oxidized	7	25.93	16	35.56	23	31.94
OX2 - Fully reduced	7	25.93	7	15.56	14	19.44
OX3 - Exterior surface oxidized, interior surface reduced	3	11.11	6	13.33	9	12.50
OX4 - Exterior surface reduced, interior surface oxidized	2	7.41	5	11.11	7	9.72
OX5 - Reduced interior and exterior surface, oxidized core	1	3.70	3	6.67	4	5.56
OX6 - Oxidized exterior surface, reduced core	1	3.70	1	2.22	2	2.78
OX7 - Uneven/no consistent pattern	6	22.22	7	15.56	13	18.06
Total	27	100.00	45	100.00	72	100.00

Table 5.24. Early and Middle Woodland Vessel Manufacture: Exterior Surface Treatment

Exterior Surface Treatment	Early Woodland		Middle Woodland		Total	
	Number	Percent	Number	Percent	Number	Percent
None	--	--	1	2.22	1	1.39
Cordmarked	25	92.59	33	73.33	58	80.56
Smoothed Over Cordmarked	2	7.41	10	22.22	12	16.67
Netmarked	--	--	1	2.22	1	1.39
Total	27	100.00	45	100.00	72	100.00

Table 5.25. Early and Middle Woodland Vessel Manufacture: Interior Surface Treatment

Interior Surface Treatment	Early Woodland		Middle Woodland		Total	
	Number	Percent	Number	Percent	Number	Percent
None	20	74.07	24	53.33	44	61.11
Smoothed Over Cordmarked	--	--	1	2.22	1	1.39
Smoothed	7	25.93	18	40.00	25	34.72
Indeterminate	--	--	2	4.44	2	2.78
Total	27	100.00	45	100.00	72	100.00

Surface Treatment

Surface treatments present in the vessel assemblages includes cordmarked, smoothed over cordmarked, netmarked, smoothed, and indeterminate (Table 5.24; Table 5.25). On some vessels more than one exterior surface treatment is present. In these cases, the dominant surface treatment is recorded. The majority of vessels exhibit a cordmarked surface finish or smoothed over cordmarked exterior treatment. Vessels lacking exterior surface treatment and netmarked exteriors are present but not well represented in the assemblage. Most vessels lack interior surface treatment. When present, the most common type of interior surface treatment is smoothing.

All of the Early Woodland vessels have cordmarked exteriors of which two exhibit a smoothed over cordmarked treatment. Early Woodland vessel interiors typically lack any surface finish although a small number are smoothed. Middle Woodland vessels exhibit a greater variety of exterior and interior surface finishes. Most Middle Woodland vessels have cordmarked exteriors, including many with smoothed over cordmarking. Vessels lacking exterior cordmarking and with netmarked exteriors are represented in the Middle Woodland assemblage. Middle Woodland vessel interiors tend to lack any treatment or are smoothed. A few vessels with smoothed over cord marked interiors are also present in the Middle Woodland assemblage.

Vessel Decoration

A variety of decorative forms are expressed on the Early and Middle Woodland vessels consisting of trailing, incising, nodes/bosses, stamping (cord-wrapped stick, dentate, stamp and drag), punctates, notching, fingernail impressions, and cordmarking (Table 5.26; Figure 5.11). All of the Early Woodland vessels are decorated and most (n=41, 91.1 percent) of the Middle Woodland vessels exhibit some form of decoration. By vessel region, nearly all of the Early Woodland vessels exhibit decoration on the body and/or rim (Table 5.27). Just over half of the Early Woodland and Middle Woodland vessels have decorated lips. Middle Woodland vessels have much lower frequencies of decoration on the rim and body as compared to the Early Woodland vessel assemblage.

Early Woodland Vessels

Decorative forms present on Early Woodland vessels consist of incised lines, cord-wrapped stick impressions, plain/smooth tool stamping, punctates, other stamping, nodes/bosses, cord-marking, and fingernail impressions (Table 5.26). The most frequent decorative form is incising that occurs on the majority (n=23, 85.19 percent) of Early Woodland vessels. Notching and punctates follow in frequency. The least represented decorative forms on Early Woodland vessels are fingernail impressions, nodes/bosses, stamping, and cord-wrapped stick impressions.

As noted above, most Early Woodland vessels (n=15, 55.56 percent) exhibit some form of decoration on the lip consisting of cordmarking, cord-wrapped stick stamping, and plain/smooth tool stamping (Table 5.28). Of the vessels with decorated lips, the most common technique (present on eight vessels) are "U"-shaped stamping, typically with a plain/smooth implement (possible dowel) or, less commonly, a cord-wrapped stick (on one vessel, vessel 3005). The notches are etched into the lip surface, extending across the exterior to interior lip margins, creating a crenelated appearance for the vessel (Figure 5.12). On one vessel (vessel 3002) the notches are more "V" shaped. Plain tool stamping, placed diagonally on the lip surface, that does not extend to the exterior or interior lip margins, is present on one vessel (vessel 3020). Seven vessels have cordmarked lips. One of the vessels with cord marked lips (vessel 3037) also has deep and "u" shaped notches created by a smooth implement that alternates along the interior and exterior lip/rim margins rather than across the lip surface (Figure 5.13).

The majority of Early Woodland vessels exhibit decoration on the rim (Table 5.27). In most cases, this consists of decorative elements that are also present on the body/upper body that extend onto the rim. As most vessels exhibit direct rims, the break between the upper body and rim is arbitrary. The most common rim decoration, present on ten vessels, consists of diagonal incised lines that are present on the upper body and extend onto the rim to near the exterior lip margin. Other decorative forms occur much less frequently and include bands of horizontal incising (n=3),

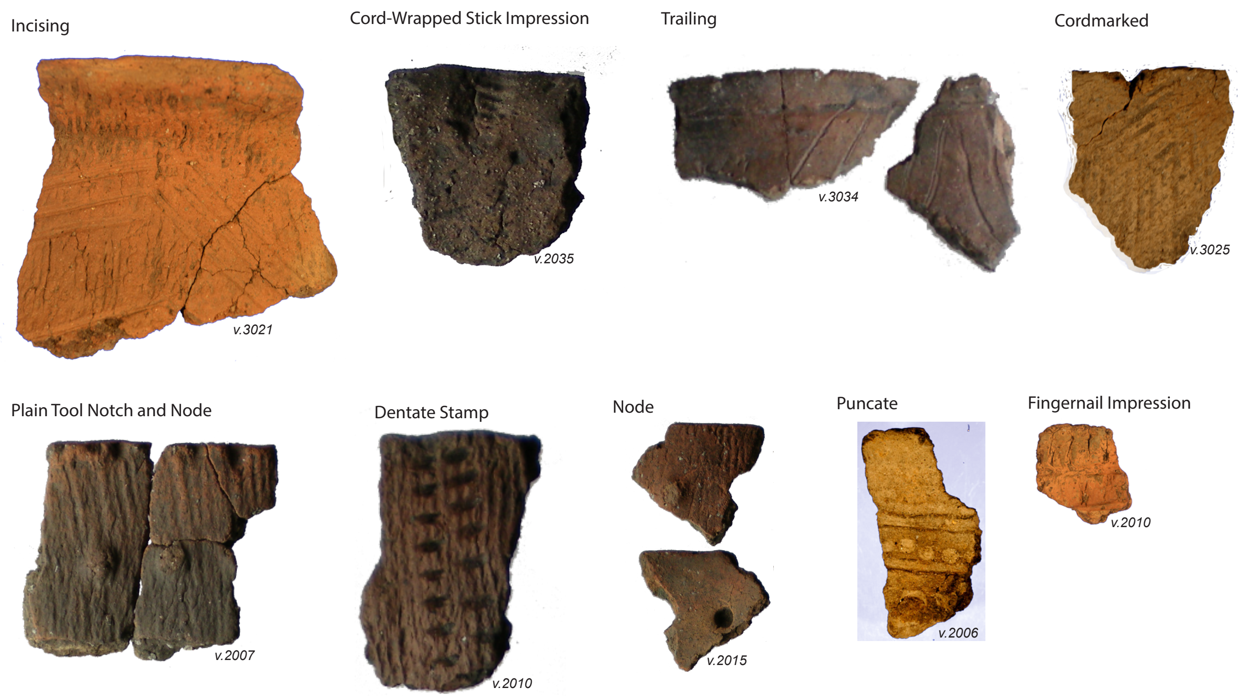


Figure 5.11. Examples of decorative forms present on the Early and Middle Woodland vessels.

Figure 5.12. Examples of crenelated forms on the Early and Middle Woodland vessels.

Table 5.26. Early and Middle Woodland Vessel Decoration: Decorative Forms

Description	Early Woodland n=27		Middle Woodland n=45	
	Number	Percent	Number	Percent
Incising	23	85.19	2	4.44
Plain/Smooth Tool Stamp	8	29.63	6	13.33
CWS Impression	2	7.41	8	17.78
Fingernail Impression	3	11.11	0	0.00
Nodes/Bosses	3	11.11	25	55.56
Punctate	4	14.81	1	2.22
Stamping	2	7.41	5	11.11
Trailing	0	0.00	4	8.89
Cordmarked	6	22.22	5	11.11
None	0	0.00	4	8.89

Table 5.27. Early and Middle Woodland Vessel Decoration: Vessel Location of Decoration

Location	Early Woodland n=27		Middle Woodland n=45	
	Number	Percent	Number	Percent
Lip	14	51.85	23	51.11
Rim	22	81.48	8	17.78
Body	26	96.30	33	73.33

Table 5.28. Early and Middle Woodland Vessel Decoration: Lip Decoration

Description	Early Woodland		Middle Woodland	
	Number	Percent	Number	Percent
Cord-marked lip surface	6	22.22	7	15.56
Cord-wrapped stick stamping	1	3.70	9	20.00
Plain/smooth tool stamping	8	29.63	7	15.56
Dentate stamping	--	--	2	4.44

bands of vertically oriented fingernail impressions (n=3), incising in a diamond pattern (n=2), vertically placed cord-wrapped stick impressions (n=1), nodes/bosses (n=1), and punctates (n=1).

With the exception of one vessel, all Early Woodland vessels have decoration present on the body of the vessel (Table 5.27; Table 5.29). Most vessels (n=14) are decorated with diagonal incised lines on the upper body; On seven vessels, below the diagonal incised lines on the upper body are bands of horizontal incising. Diagonal incising with punctates is present on three vessels. Other decorative modes include bands of horizontal incising (n=3), diamond patterned incising (n=2), bands of vertical fingernail impressions underlain by horizontal incising or nodes (n=2), vertical cord-wrapped stick impressions (n=1), and nodes (n=1).

Three design motifs are recognized for the Early Woodland pots based on the types and location of decoration (Figure 5.14). These three motifs are designated as A, B, and C and are present on 18 of the Early Woodland vessels. The remaining nine Early Woodland vessels were too unique, or too fragmentary, to be classified into one of the three design motif groups. As all of the vessels are represented by rim and upper body segments, the design motifs apply only to those portions of the vessel.

Design Motif Group A

A total of nine vessels exhibit design motif A (v.3001, 3002, 3004, 3005, 3006, 3010, 3012, and 3013). These vessels exhibit very thick and deep diagonal incised lines on the upper rim and neck that extend to the lip margin. The thickness of the incised lines ranges from 0.26 cm to 0.39 cm thick. The area of the diagonal lines extends from the top of the vessel to between 1.23 cm to 2.26 cm below the top. Below the thick, diagonal lines are horizontal bands of incised lines. On one vessel, (v.3010) a horizontal row of punctates occur at the top of the upper most horizontal band of incised lines. Vessels within the design motif group A are similar to the type description for Waubesa Incised (Salkin 1986).

Table 5.29. Early and Middle Woodland Vessel Decoration: Body Decoration

Description	Early Woodland n-27		Middle Woodland n=45	
	Number	Percent	Number	Percent
Incising	19	70.37	2	4.44
Fingernail	2	7.41	--	--
CWS Stamp	1	3.70	2	4.44
Nodes	1	3.70	21	46.67
Punctates	3	11.11	1	2.22
Cord-marked	--	--	1	2.22
Dentate Stamp	--	--	4	8.89
Plain Tool Stamp	--	--	2	4.44
Trailing	--	--	5	11.11

Figure 5.13. Example of U-shaped interior notch on an Early Woodland vessel (v.3037).

Design Motif Group B

A total six vessels are grouped as design motif B (3003, 3008, 3016, 3020, 3021, and 3035). Design Motif Group B vessels are defined by more finely incised lines that occur in a diagonal, criss-cross, and/or triangular patterns just below the lip. On vessel 3021, which exhibits a everted rim, the incising does not extend onto the rim. For two vessels, the incised lines are present in a very finely executed cross hatch pattern. The area of the incising extends from the top of the vessel to 3.4 cm below the top (based on vessel 3008). Below the area of incised lines are bands of horizontal incised lines. On vessel 3035, there is also a single horizontal band of incising just below the lip. One vessel (3003) has a horizontal row of punctates just below the area of diagonal incised lines. Design Group B, along with Design Group B, may conform to the typological class, Beach Incised (Salkin 1986).

Design Motif Group C

Three vessels exhibit design motif group C (3009, 3018, and 3038). These vessels exhibit diagonal incised lines just below the lip. The diagonal incised lines form triangular areas that are filled, in an alternating pattern, with horizontal incised lines or cordmarking. Below this area are bands of horizontal incised lines. As noted above, Design Group C may conform to the typological class, Beach Incised (Salkin 1986).

<u>Middle Woodland Vessels</u>

Decorative forms present on Middle Woodland vessels include incising, notching, cord-wrapped stick impressions, nodes/bosses, punctates, stamping, trailing, and cordmarking (Table 5.26). The most frequent decorative technique is the occurrence of nodes/bosses, present on 25 vessels (55.56 percent). Cord-wrapped stick impressions (n=8, 17.78 percent) and notching (n=6, 13.33 percent) follow in frequency. Least represented decorative forms include stamping, cordmarking, trailing, incising, and punctates.

Some form of lip decoration is present on just over one-half (n=23, 51.11 percent) of the Middle

Woodland vessels (Table 5.28). Lip decoration modes include cord-marking, cord-wrapped stick stamping, plain/smooth tool stamping, and dentate stamping. Cord-wrapped stick stamping is the most common lip decorative technique and several variations are present on the Middle Woodland vessels. Cord-wrapped stick stamping is placed vertically on the exterior lip margin (n=3), on the interior lip margin (n=4), and on the lip surface (n=4). For the vessels that have cord-wrapped stamping on the lip surface, on all but one the stamping extends across the exterior and interior lip margins, creating a crenelated appearance (Figure 5.12). Plain/smooth tool stamping is typically placed vertically on the interior lip margin (n=5), although stamping on a cord-marked lip surface (n=1) and diagonally on the exterior lip margin (n=1) are also represented in the assemblage. Seven vessels have cord marked lips; of these, five have cordmarked lips as the sole decoration while two have stamping (cord-wrapped stick and plain/smooth tool). Finally, two vessels have dentate stamping oriented vertically that occurs on both the interior and interior lip margins and solely on the exterior margin.

Few Middle Woodland vessels (n=9, 20 percent) have decoration present on the rim (Table 5.27). Similar to the Early Woodland vessels, as most Middle Woodland vessels have direct rims, the break between the rim and upper body is arbitrary. As such, the decoration on the rims typically reflects an extension of elements present on the lip and/or on the upper body with three notable exceptions. Vessel 2001 exhibits trailed lines interrupted with nodes/bosses. Vessel 2009 exhibits dentate stamping placed vertically on the rim; This vessel also has dentate stamping along the interior lip margin and rim. Lastly, vessel 3034 has a band of horizontal incised lines placed at the base of the rim.

The majority of Middle Woodland vessels (n=33, 73.33 percent) have decorative elements present on the vessel body (Table 5.27; Table 5.29). Decorative forms including cord-marking, cord-wrapped stick stamping, dentate stamping, incising, nodes/bosses, plain tool stamping, and trailing. Many vessels have multiple elements present. The most common decorative element, present on 21 vessels, consists of nodes/bosses. In many instances, the nodes/bosses are the sole decoration, but they also occur with dentate stamps, trailing, and punctates.

Most the Middle Woodland vessels (n=34) could be grouped into three motif groups, designated as L, M, and N, based on overall similarity of vessel design elements (Figure 5.15). The remaining six vessels exhibit fairly unique design elements and are not placed within a motif group.

Design Motif Group L

A total of 21 Middle Woodland vessels exhibit nodes/bosses as typically the sole body decoration, occurring with undecorated lips/rims (n=16), cordmarked lips (n=2), or lips with plain tool stamping (n=4). One vessel that also exhibits broad trailed lines on the body is included in this group based on the overall similarity to other vessels in the group. Vessels in Middle Woodland Design Motif Group L conform well with the Shorewood Cord Roughened typological classification (Baerris 1952; Salzer n.d.).

Design Motif Group M

A total of eight Middle Woodland vessels conform to Design Motif Group M. These vessel lack any decoration on the body but exhibit decorated lips consisting of cord-wrapped stick stamping, plain tool stamping, or cord-marking. Vessels in Design Motif Group M may be classified as Kegonsa Stamped.

Design Motif Group N

A total of five vessels are classified into Design Motif Group N. These vessels exhibit cord-wrapped stick, plain tool, or dentate stamping on the vessel body as well as on the lip. Vessels in this design group may be typed as Kegonsa Stamped and/or Naples Stamped.

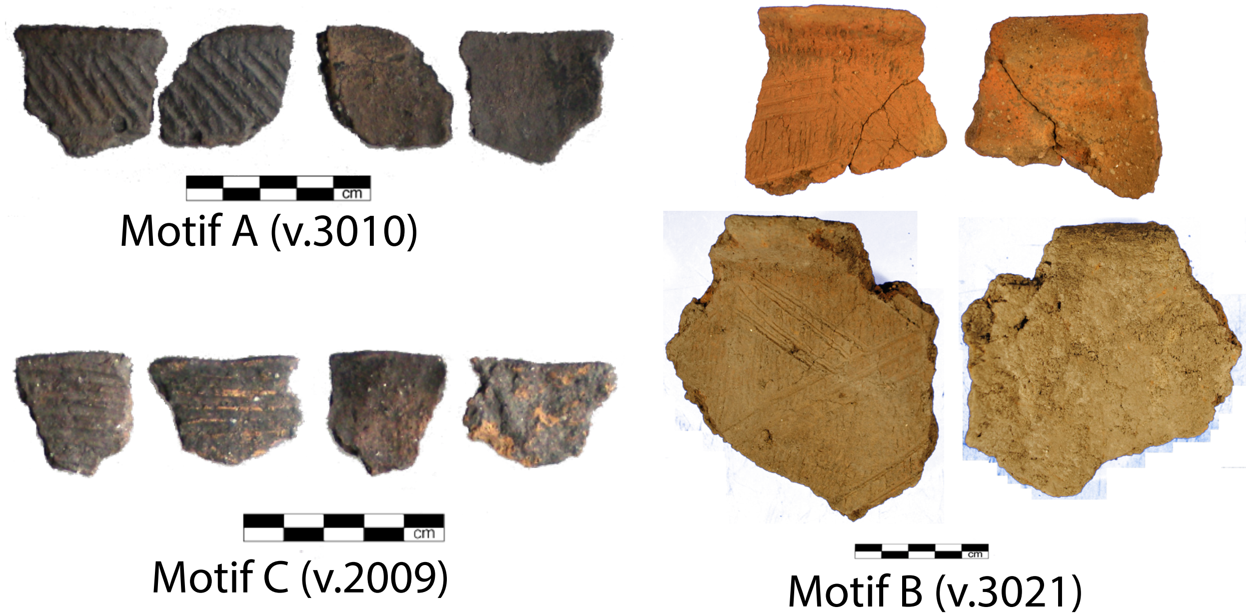


Figure 5.14. Design motifs observed on the Early Woodland vessels.

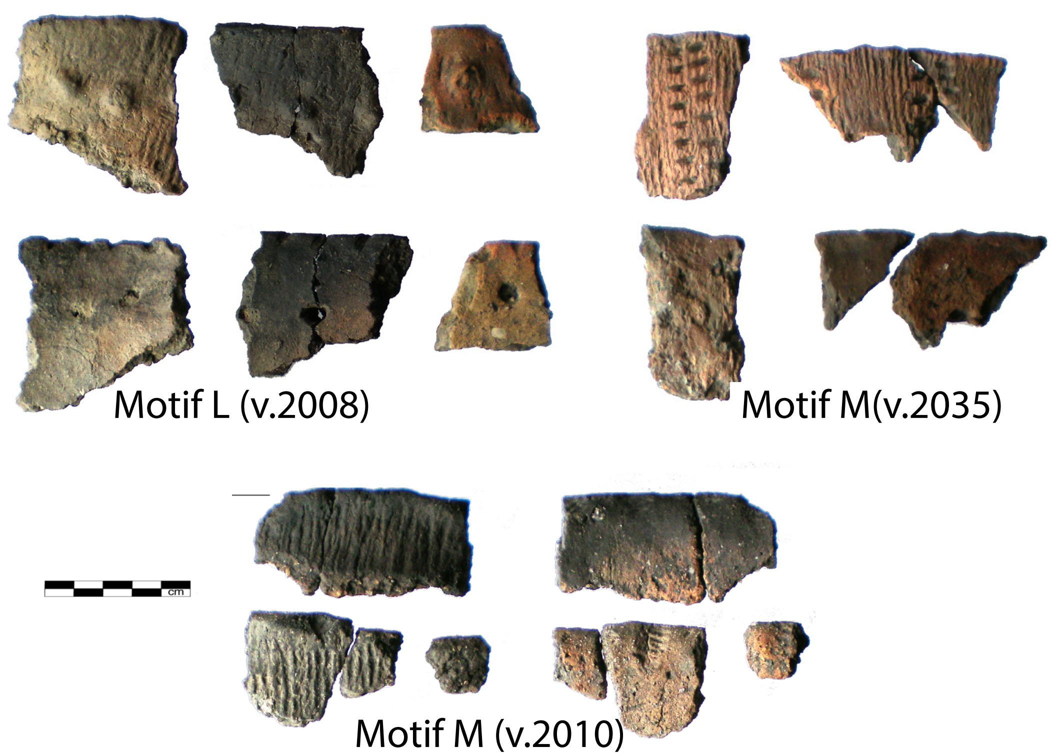


Figure 5.15. Design motifs observed on the Middle Woodland vessels.

Discussion and Assessment of Variation

The attribute analysis reveals much variability both within and between the Early and Middle Woodland ceramic assemblage (Table 5.30). Based on the attribute analysis, there are some key similarities and differences between the Early and Middle Woodland vessel assemblage. The Early Woodland vessels can exhibit thickened or thickened/folded rims and have higher frequencies of decoration on the rim as compared to Middle Woodland vessels. Early Woodland vessels have fewer jar form shapes, tend to be smaller, and have thinner walls than Middle Woodland pots. Middle Woodland pots also have greater variability with regard to lip form, have more jar form shapes, and tend to be larger vessels with thicker walls.

The overall variation present in the Early and Middle Woodland vessels assemblages is important to the dissertation research project. The variation is measured in three ways: the numeric range of quantitative variables, evaluating the number of types expressed by the qualitative variables, and relative frequencies of vessels classifiable to a design motif.

Assessing the numeric range of quantitative variables, orifice diameter and wall thickness, is straightforward. Based on numeric ranges, Middle Woodland vessels display a narrower range of variation relative to wall thickness and exhibit a greater range of variation in orifice diameters (Table 5.11; Table 5.15).

Variation in qualitative attributes is examined through the number of different types expressed by the vessel assemblage associated with each component (Table 5.31). Comparing the Early and Middle Woodland vessels assemblage, the number of expressed types increases, decreases, or remains consistent. The attributes that exhibit no change in the number of expressed types include lip form, paste core, compactness, and temper. Attributes that exhibit an increase in the number of expressed types from the Early to Middle Woodland consist of jar form, rim stance, vessel size class, exterior surface treatment, overall decorative forms, lip decoration forms, and body

Table 5.30. Comparison of the Early and Middle Woodland Vessel Based on Attribute Analysis

Attribute	Early Woodland	Middle Woodland
Vessel Form	Jar	Jar
Jar Form	Globular, conoidal	Conoidal, globular, **tecomate, sub-conoidal**
Rim Form	Direct, stlightly everted, everted	Direct, slightly everted, everted, **slightly inverted, inverted**
Rim Shape	Unmodified, pinchesd, folded, **thickened, thickened and folded**	Unmodified, folded, pinched
Lip Form	Flattened, rounded, beveled	Flattened, rounded, beveled
Vessel Diameter	Small, small-medium, and medium-large	Small, small-medium, and medium-large, and **large**
Vessel Size	Average 18.33 mm Less variation in size range	Average 22.53 mm Greater variation in size range
Thickness	Average 7.72 mm	Average 8.51 mm
Temper	Grit, **sand**	Grit
Paste	Friable, compact, very compact	Friable, compact, very compact
Oxidation	Most vessels are oxidized but all categories are represented	Most vessels are oxidized but all categories are represented
Surface Treatment	Cord-marked, smoothed over cord-marked **All vessels exhibit exterior surface treatment**	Cord-marked, smoothed over cord-marked, **net-marked** **Some vessels lack exterior surface treatment**
Decoration	**Incising** most frequent Most vessels have decorated lips **All** vessels decorated	**Nodes/bosses** most frequent Most vessels have decorated lips **Most** vessels are decorated

decoration form. The only qualitative attribute that exhibits a decrease in the number of expressed types on Middle Woodland vessels versus Early Woodland vessels is rim shape.

The relative frequencies of design motifs is further explored to address variation (Table 5.32). The Early and Middle Woodland vessels each exhibit three unique forms of design motifs. For the Early Woodland pots, 66.67 percent (n=18) are classed as having design motifs A, B, or C. The Middle Woodland assemblage has a slightly higher relative frequency (75 percent, n=34) of vessels assignable to a particular design motif.

Results of the Functional Analysis

A functional analysis is conducted on the Early and Middle Woodland vessels assemblage that identifies intended and actual use of individual vessels through macroscopic techniques and chemical analyses. Intended vessel use is first reviewed, followed by a discussion of actual use. Actual use include a use-alteration analysis, examining presence and patterns of sooting and attrition, and chemical residue analysis on a sample of the pots.

Intended Function

Intended function, those aspects of vessel manufacture that measurably enhance performance, is assessed using: vessel morphology (general form, size, and rim orientation), vessel wall thickness, temper characteristics, and surface treatment (Braun 1983, 1987; Hally 1986; Kooiman 2016; Reid 1990; Rice 1987; Rye 1976; Schiffer et al. 1994; Skibo 2013).

The Early and Middle Woodland vessels recovered from Finch are all considered to have a cooking or storage function, as all define jars and the site type is a domestic habitation (Hally 1986; Rice 1987; Skibo 2013; Smith 1988). Cooking pots are structurally adapted to simmering or boiling liquid (water or food) through direct contact with external heat (flame or coals) or through an indirect process of stone-cooking (Linton 1944; Sassaman 1991). Effective cooking pots require a large enough opening to prevent boil overs and permit stirring, but small enough,

Table 5.31. Early and Middle Woodland Vessels: Variation of Qualitative Attributes

Attribute Descritpion	Total Number of Types	Early Woodland: Number of Types	Middle Woodland: Number of Types
Vessel Morphology			
Jar Form	4	2	4
Rim Stance	5	3	5
Rim Shape	5	5	3
Lip Form	3	3	3
Vessel Size Class	4	3	4
Vessel Manufacture			
Paste Core	7	7	7
Compactness	2	2	2
Fracturing			
Temper	5	4	4
Exterior Surface	4	2	4
Interior Surface	3	2	3
Vessel Decoration			
Overall	10	9	10
Lip Decoration	4	3	4
Body decoration	9	5	8

Table 5.32. Early and Middle Woodland Vessels: Relative Frequency of Vessels with Design Motifs

Design Motif	Number	Percent
Early Woodland Vessels (n=27)		
Design Motif A	9	
Design Motif B	6	
Design Motif C	3	
Subtotal Design Motifs	18	66.67
No Design Motif	9	33.33
Middle Woodland Vessels (n=45)		
Design Motif L	21	
Design Motif M	8	
Design Motif N	5	
Subtotal Design Motif	34	75.00
No Design Motif	11	25.00

relative to the pot's capacity and heating surface, to prevent it from boiling dry every few minutes (Linton 1944:370; Skibo 2013).

With the exception of one vessel, all of Early and Middle Woodland vessels exhibit some type of exterior surface treatment and are heavily tempered with granitic grit. These characteristics increase thermal shock resistance and supports the interpretation that the pots were designed for cooking related tasks. All of the Finch vessels have slightly restricted or unrestricted orifices, allowing vessel contents to be easily accessed, facilitating manipulation of vessel contents during cooking (Skibo 2013).

The jars include conoidal, subconoidal, globular, and neckless (tecomate) forms with direct or everted/slightly everted/slightly inverted rims with unrestricted orifices. Globular and tecomate forms would have likely had a curved base/round bottom, an attribute that increases strength but decreases stability. The conoidal and sub-conoidal forms, having conical bases, would not be able to independently stand upright, lacking stability, and requiring other technologies to hold them upright (Shepard 1956; Skibo 2013). All vessels forms represented in the assemblage have low stability, further implicating them as cooking pots rather than serving or storage (Skibo 2013).

To explore whether jar forms were intended for different uses, the attributes that correspond closely to vessel performance are summarized for the jar forms and then formally compared through relative frequencies and multiple correspondence analysis. The attributes consist of size, rim stance, thickness, exterior and interior surface treatment, and temper type. Jars with an indeterminate form are not included in the analysis. In all, 60 vessels are included in the analysis, consisting of 15 Early Woodland vessels and all of the Middle Woodland vessels (n=45).

Relative frequencies of size, rim stance, thickness, exterior surface treatment, interior surface treatment, and temper are examined for the globular, conoidal, and sub-conoidal vessels (Table 5.33). Only one vessel is classified as a neckless jar and is therefore not included in the relative frequency calculations. The tecomate is a small grit-tempered (crushed granitic grit) vessel, lacking

Table 5.33. Relative Frequency of Intended Function Attributes by Jar Form

Attribute Description	Globular Jars n=13	Conoidal n=43	Sub-Conoidal n=3
Size			
Small	23.08	18.60	--
Small/Medium	61.54	25.58	66.67
Medium/Large	--	20.93	33.33
Large	--	9.30	--
Rim Stance			
Direct	53.85	48.84	33.33
Everted or Slightly Everted	46.15	27.91	66.67
Slightly Inverted	--	23.26	--
Thickness			
Thick Walled	30.77	67.44	66.67
Thin Walled	69.23	34.88	33.33
Exterior Surface Treatment			
Cord-marked	76.92	83.72	66.67
Net-marked	7.69	0.00	--
Smooth over cord-marked	15.38	16.28	33.33
None			
Interior Surface Treatment			
None	69.23	46.51	100.00
Smoothed	30.77	44.19	-
Cordmarked	--	4.65	--
Indeterminate	--	4.65	--
Temper			
Crushed granitic grit	84.62	48.84	66.67
Granite & pebbles	7.69	23.26	--
Granite & feldspar	7.69	23.26	33.33
Granite & mafic	--	4.65	--

exterior surface treatment, with an inverted rim stance, thin walls, and smoothed interior surface.

Relative frequencies characterize the attributes commonly associated with globular, conoidal, sub-conoidal, and conoidal vessel forms (Table 5.33). Globular jars are typically thin-walled, small or small/medium sized cord-marked vessels with direct or everted rims, tempered with granitic grit, and lacking interior surface treatment. Conoidal jars are thick walled, cord-marked vessels tempered with granitic grit. Conoidal jars are of various sizes, but most common are small/medium and medium/large vessels. Rims of conoidal jars are typically direct, but everted/slightly everted and slightly inverted also occur. Sub-conoidal jars are small/medium sized, grit-tempered (crushed granitic grit) thick-walled vessels with everted/slightly everted rims, cord marked exteriors, and plain interiors.

The initial data exploration employing multiple correspondence analysis includes the following variables: jar form type, size classification, rim stance, thickness, exterior surface treatment, interior surface treatment, and temper (Figure 5.16; Appendix F). The rim stance category collapses everted and slightly everted rims into single category. Interior surface treatment is marked as present or absent. The resultant analysis indicates that factors 1 and 2 account for a fairly low percentage (29.47 percent) of the variation. The vessels plotted on the first two components indicates that the tecomate form is substantially different from all other jar forms.

Multiple correspondence analysis is run using the same variables as listed above for jar form type (size classification, rim stance, thickness, exterior surface treatment, interior surface treatment, and temper), but omitting the tecomate (Figure 5.17). The resultant plot, with the first two factors accounting for 26.94 percent of the data, indicates some patterning based on vessel form. Globular vessels are associated with the small/medium size class, direct and everted rims, thin walls, a lack of interior surface treatment and crushed granite temper. Conoidal vessels tend have thick walls, medium/large and large vessel sizes, and granite temper with pebbles. However, a strong pattern is not evident and the correspondence analysis accounts for a relatively low percentage of variation.

In an attempt to identify a stronger pattern that accounts for a higher percentage of data variation, multiple analysis is conducted on those attributes that, based on relative frequency, are the most dissimilar between the conoidal, sub-conoidal, and globular vessel forms. Globular, conoidal, and sub-conoidal jars exhibit similar frequency profiles with regard to exterior surface treatment (cord-marked), the lack of interior surface treatment, rim stance, and temper type (crushed granitic grit). Attributes that are most dissimilar among the jar types consist of vessel size and thickness.

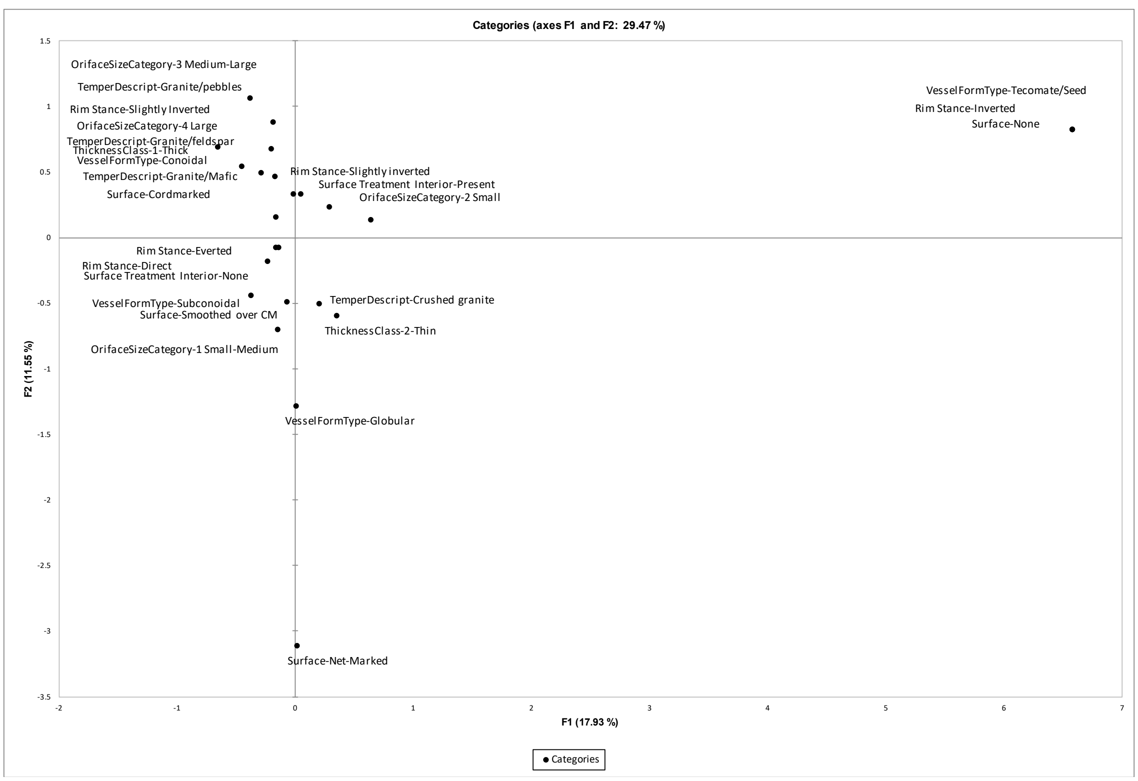


Figure 5.16. Multiple correspondence analysis based on vessel form, size, rim stance, thickness, surface treatment, and temper. Vessels plotted using factors 1 and 2.

Based on these attributes, multiple correspondence analysis is conducted to further explore the relationship between jar form, vessel size, and thickness. The tecomate is excluded from the calculation. The resultant plot accounts for 48.53 percent of the data and indicates a distinction between the globular vessels and conoidal vessels (Figure 5.18). The globular vessels are associated with the small/medium sized vessel class. Conoidal vessels are linked with thick walls and the medium/large vessel class. The sub-conoidal vessels are not close to any size class or wall thickness attributes.

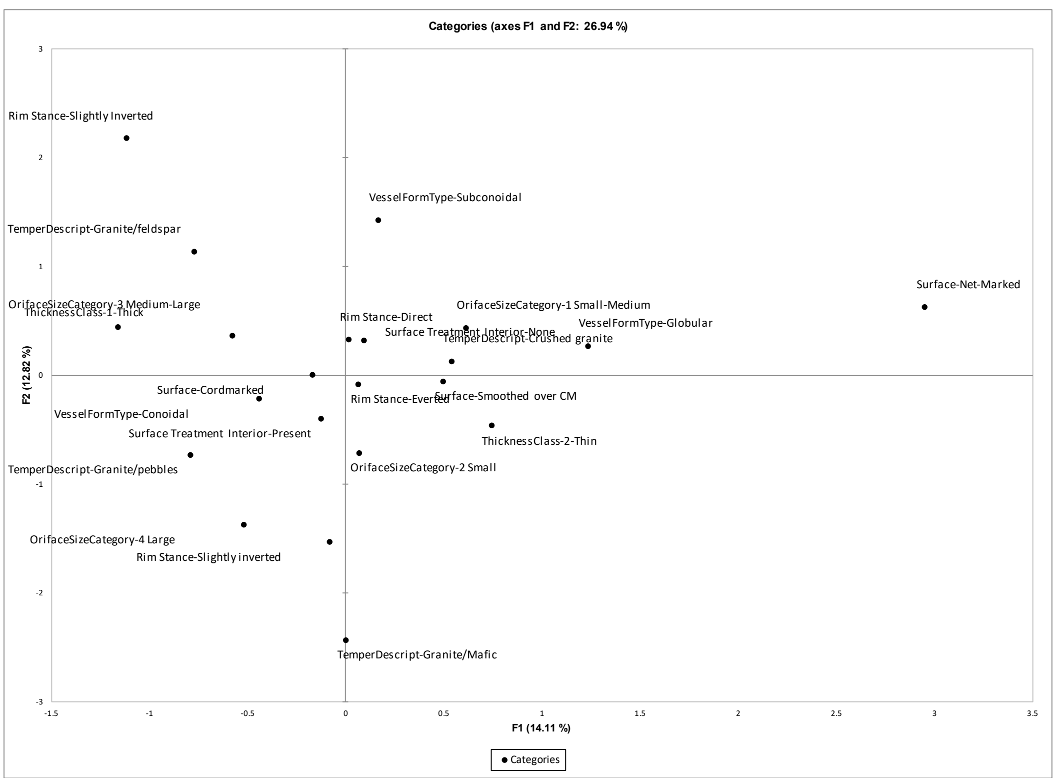


Figure 5.17. Multiple correspondence analysis based on vessel form, size, rim stance, thickness, surface treatment, and temper, omitting the neckless jar. Vessels plotted using factors 1 and 2.

These data suggest that, although the globular and conoidal jars were both designed for cooking, the vessels were intended to be used for different types of cooking related tasks. The small, thin walled globular vessels may have been designed for rapid heating, with the thin walls allowing vessel contents to come to a boil quickly (Rice 1987; Skibo 2013). All of the globular vessels have unrestricted orifices, allowing easy access to vessel contents during cooking and for serving. Globular vessels have exterior surface treatments, typically cord-marking, with few also exhibiting interior surface treatments. The surface treatments, coupled with the thin walls, would allow the globular vessels to be fairly resistant to thermal shock. Cordmarking on the exterior would also facilitate handling if used to serve foods.

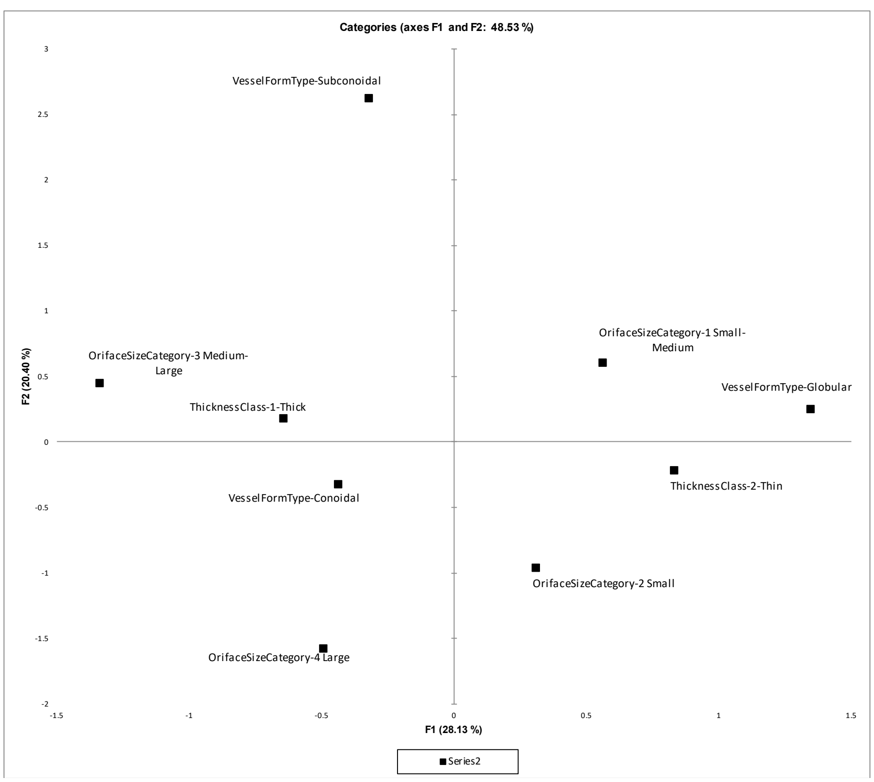


Figure 5.18. Multiple correspondence analysis based on vessel form, size, and thickness, omitting the neckless jar. Vessels plotted using factors 1 and 2.

The conoidal vessels are associated with thicker walls and the medium/large vessel size class. The vessel form would not allow the vessel to stand upright independently (Shepard 1956), thus these pots were likely placed directly in and/or over a fire or coals, supported by some other means. The round base of the conoidal jar, if placed directly in or over a fire or coals, would facilitate air flow and increase combustion. The thicker walls indicate that the vessels may have been designed for lower temperature and longer term cooking, such as simmering. As with the globular vessels, most of the conoidal vessels have unrestricted orifices allowing for easy manipulation of the vessel contents during cooking and/or for serving. Just under one-quarter of the conoidal vessels have slightly inverted rims that may reflect a design attempt to restrict convection heat loss through the orifice (Linton 1944; Sassaman 1991). The larger vessel size class associated with the conoidal vessels further suggests that the jars were designed to cook a larger volume of food, possibly implicating a larger sized social group (Blitz 1993).

The neckless jar form, of which there is only one form in the assemblage, has an inverted rim stance, thin walls and is small in size. The small size and thin walls may have been designed for rapid heating, with the thin walls allowing vessel contents to come to a boil quickly. The globular shape is well adept at thermal shock resistance The inverted rim stance would have restricted accessibility during cooking and/or serving. The inverted design may have been an attempt to restrict convection heat loss through the orifice.

Actual Function: Use Alteration Analysis

The actual function of the Early and Middle Woodland vessels is examined through evidence of use alteration traces. These traces consist of exterior sooting patterning, interior carbonization, and attrition. The majority of Finch vessels exhibit some type of use alteration, consisting of sooting, exterior sooting and/or interior carbonization, and/or attrition (Table 5.34). Middle Woodland vessels have a slightly higher frequency of use alteration occurrence as compared to the Early Woodland vessels.

Patterns of exterior sooting and interior carbonization are used to delineate various activities for which a vessel was used. The presence/absence of sooting and carbonization, as well as the location on a vessel of such alteration, are the clues important for distinguishing between differing type of cooking and processing techniques. The presence and patterning of sooting or carbonization on the mid-body, lower body, and bottom vessel portions (interior and exterior) are especially useful for distinguishing between cooking modes and hearth design (Skibo 2013) (Table 5.5, Table 5.6). As such, the use of whole vessels, or nearly complete reconstructed vessels, are the preferred data set for ceramic functional analysis. Although the Finch site ceramic assemblage lacks any whole vessels, as well as any reconstructed specimens, the partial vessels represented in the assemblage can be subjected to a use alteration study, with, as Skibo aptly characterizes, some "trickery" (Skibo 2013).

Table 5.34. Early and Middle Woodland Vessel Use Alteration: Overview of Types

Use Alteration	Early Woodland		Middle Woodland		Total	
Description	Number	Percent	Number	Percent	Number	Percent
Present						
Sooting	2	7.41	6	13.33	8	11.11
Sooting & Attrition	9	33.33	19	42.22	28	38.89
Attrition	6	22.22	7	15.56	13	18.06
Subtotal Present	17	62.96	32	71.11	49	68.06
None	10	37.04	13	28.89	23	31.94
Grand Total	27	100.00	45	100.00	72	100.00

Given the lack of whole or reconstructed vessels in the Finch assemblage, two techniques are adopted for the Finch site ceramic functional analysis. First, the use alteration analysis is initially conducted on a subset of the vessels, that define the most complete vessels, to provide an overall assessment of the types of patterning that is present. Second, the use alteration analysis considers the portion of the vessel present to directly address bias resulting from the presence/absence of data versus the presence/absence of a particular trait. For example, for a vessel defined by rim/upper body sherds, it is only appropriate to compare it to other vessels that are also solely defined by rim/upper sherds, rather to those vessels which have mid and lower body portions represented.

All of the Finch vessels are represented by rim sherds, with some also defined by adjoining upper body, and mid-body sherds. Few lower body sherds or no definitive basal sherds are directly associated with the Finch vessels. The lack of lower body and basal sherds relates to the way in which vessels are delineated, largely focused on the similarity of decoration and re-fits. As most Early and Middle Woodland vessels exhibit decoration on the upper vessel portions, it is rim and upper body portions that are most represented in the vessel assemblage. Moreover, given the high quantities of undecorated ceramics from any given provenience, tremendous effort would be required for vessel reconstruction, well beyond the scope of this dissertation research project.

To address bias resulting from the portion of the vessel represented in the assemblage, use-alteration independently considers the patterning on two subsets of the vessels: Subset A and Subset B, as well as for the entire assemblage. Subset A vessels are the more complete vessels represented by rim, upper body, mid-body, and lower body sherds. Subset B vessels are less complete, typically defined by rim and upper body fragments. Of the 72 vessels identified at Finch, 34 vessels fall into Subset A and 38 vessels are categorized in Subset B (Table 5.35). Data is presented for the assemblage as a whole as well as for each subset.

Sooting and Interior Carbonization

Of the 72 vessels, a total of 36 vessels in the assemblage exhibit exterior sooting and/or interior carbonization (Table 5.36, Table 5.37). By relative frequency, exactly one-half of all vessels have some type of fire alteration. Middle Woodland vessels have a higher frequency of sooting/carbonization (n=25, 55.56 percent) as compared to Early Woodland vessels (n=11, 40.74 percent) (Table 5.35). Of the 34 vessels in the Subset A vessel group, the majority (n=21, 61.76 percent) exhibit some type of fire alteration (Table 5.37). The Middle Woodland vessels have a slightly higher frequency of fire alteration as compared to the Early Woodland vessels. The Subset B vessel group has a lower relative frequency of fire alteration, with 37.47 percent (n=15) of the vessels having exterior sooting or interior carbonization (Table 5.35). Early Woodland vessel in Group B have a much lower frequency of fire alteration (n=3, 20.00 percent) as compared to the Middle Woodland vessels (n=12, 52.17 percent). The lower frequency of fire alteration on Subset vessel group B as compared to Subset A vessels is likely attributable to the portion of the vessel represented. This observation is explored further in the patterns of exterior sooting and interior carbonization as described below.

Exterior Sooting

The presence of exterior sooting provides direct evidence of the use vessels over fire for cooking and/or processing tasks (Hally 1983). Only a small proportion of cooking events would be expected to result in exterior carbonization, so low frequencies in archaeological collections are typically expected (Graff 2018; Kooiman 2018; Morrison et al. 2015). In all, a total of 26 vessels, representing 36.11 percent of the Early and Middle Woodland vessel assemblage, exhibit exterior sooting (Table 5.38). Early Woodland and Middle Woodland vessels have similar relative frequencies of exterior sooted vessels. Fully 33.33 percent of Early Woodland vessels are sooted on the exterior and 37.78 percent of the Middle Woodland vessels have exterior soot (Table 5.38).

The high frequency (n=46, 63.89 percent) of vessels lacking exterior sooting may be skewed by the percentage of the vessel that is represented, potentially under-representing the number and

Table 5.35. Overview of the Vessel Assemblage by Vessel Group

Category	Early Woodland		Middle Woodland		Total	
	Number	Percent	Number	Percent	Number	Percent
Subset A-Rim & Body	12	44.44	22	48.89	34	47.22
Subset B-Rim	15	55.56	23	51.11	38	52.78
Total	27	100.00	45	100.00	72	100.00

Table 5.36. Early and Middle Woodland Vessel Use: Presence of Fire Alteration

Fire Alteration	Early Woodland		Middle Woodland		Total	
Description	Number	Percent	Number	Percent	Number	Percent
	n=27		n=45		n=72	
Fire Alteration (Exterior or Interior)	11	40.74	25	55.56	36	50.00
Exterior Soot	9	33.33	17	37.78	26	36.11
Interior Carbonization	10	37.04	23	51.11	33	45.83

Table 5.37. Relative Frequency of Fire Alteration (Exterior Soot and/ or Interior Carbonization) Traces by Vessel Subset.

Description	Number of Vessels	Early Woodland		Middle Woodland		Total	
		Number	Percent	Number	Percent	Number	Percent
All Vessels	72	11	40.74	25	55.56	36	50.00
Subset A	34	8	66.67	13	59.10	21	61.76
Subset B	38	3	20.00	12	52.17	15	39.47

Note: Relative frequency calculated using the number of vessels associated with each component. See Table 5.35.

frequency of sooted vessels in the assemblage. Examining the relative frequency of sooting by the vessel subsets partially addresses this issue (Table 5.38). Vessel Subset A, the more complete vessels, exhibit exterior sooting at a rate of 52.94 percent (n=18). By component, Early Woodland pots in Group A display a higher frequency of exterior sooting as compared to the Middle Woodland wares.

The more complete vessels, Subset A, are examined relative to the patterning of exterior sooting, delineated through the relative frequencies of exterior soot occurrence by vessel region (Table 5.39). Three types exterior soot occurrence is evident in the assemblage consisting of soot presence on the rim/lip, the rim and upper body, and on the vessel body (upper and/or mid body) (Figure 5.19). Exterior sooting is most prevalent on the upper body/body (n=7, 38.89 percent) and rim/lip (n=7, 38.89 percent). Least common is exterior sooting on both the rim and upper body (n=4, 21.05 percent). The presence of soot on the exterior lip may indicate charred residue from the pouring out of vessel contents and/or splattering during cooking.

Early and Middle Woodland pots display different relative frequencies of exterior sooting by vessel region (Table 5.39). Exterior sooting on Early Woodland wares is most common on the vessel body (n=4, 57.15 percent) followed by the rim/lip (n=2, 28.57 percent), and the rim and

Table 5.38. Comparison of Exterior Sooting Relative Frequencies by Vessel Group

Vessel Category	Early Woodland		Middle Woodland		Total	
	Number of Vessels	Percent	Number of Vessels	Percent	Number of Vessels	Percent
All Vessels	9	33.3	17	37.78	26	36.11
Subset A	7	58.33	11	50.00	18	52.94
Subset B	2	13.33	6	26.09	8	21.05

upper body (n=1, 14.29 percent). The Middle Woodland wares exhibit a high frequency of rim/lip exterior sooting (n=5, 45.45 percent) followed by equal representation of sooting on the rim and upper body and on the body (Table 5.39).

The patterning present on the less complete vessels (Subset B) supports the patterning observed on the more complete vessels (Subset A). Exterior sooting is evident on eight of the Group B vessels, a frequency of 21.05 percent (Table 5.38). Exterior sooting is more prevalent on Middle Woodland vessels as compared to the Early Woodland vessels. The higher frequency of sooting on the Group B Middle Woodland pots concords with the data from the more complete vessels (Subset A) that exhibited a high frequency of exterior sooting on the Middle Woodland wares, especially on the lip/rim region.

Interior Carbonization

Food residue burned into the interior vessel surface provides direct evidence of the use of a pot for cooking and resource processing (Kooiman 2016, 2019; Skibo 2013). The patterning of carbonization and chemical composition of lipids preserved in the vessel fabric are integral component for the reconstruction of cooking activities and food selection habits (Kooiman 2018). Interior carbonization is present on 33 vessels in the assemblage, a relative frequency of 45.83 percent (Table 5.40). Early and Middle Woodland wares exhibit a similar frequency of interior carbonization, with interior charring on Middle Woodland pots slightly more prevalent. That most vessels in the assemblage do not exhibit interior carbonization is likely linked to the completeness of the vessel from which the data is recorded. To address this issue, the relative frequency of interior carbonization is independently examined for the mostly complete vessels (Subset A) and the less complete vessels (Subset B).

The majority, fully 61.76 percent (n=21) of Subset A vessels have interior carbonization (Table 5.40). Early Woodland vessels in Subset A have a higher frequency of interior carbonization (n=8, 66.67 percent) than the Middle Woodland vessels (n=13, 59.10 percent). The Subset B

Table 5.39. Relative Frequency of Exterior Soot on Vessels - Subset A

Location		Early Woodland n=12		Middle Woodland n=22		Total n=33	
	Label	Number	Percent	Number	Percent	Number	Percent
Type 1: Rim/Lip	EXT-1	2	28.57	5	45.45	7	38.89
Type 2: Upper Body and/or Body	EXT-2	4	57.15	3	27.27	7	38.89
Type 3: Rim and Upper Body	EXT-3	1	14.29	3	27.27	4	21.05
Total		7	100.00	11	100.00	18	100.00

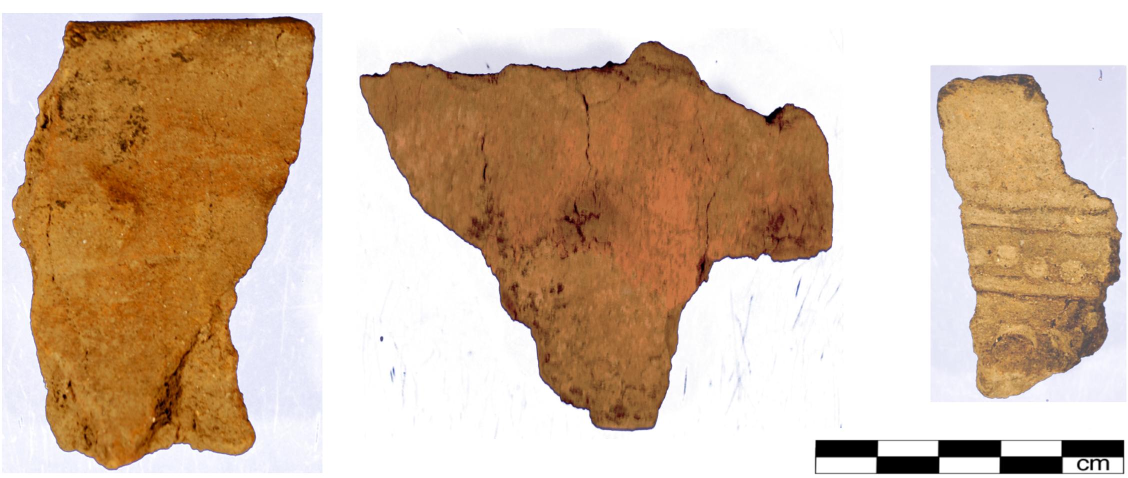


Figure 5.19. Type of exterior sooting expressed in the Early and Middle Woodland vessel assemblage. Left: Exterior Type 1 (EXT 1, v.2005); Middle: Exterior Type 2 (EXT 2, v.2003); Right: Exterior Type 3 (EXT 3, v.2006)

vessels exhibit a low occurrence of interior carbonization as only 13 vessels, or 34.21 percent, have interior charring (Table 5.40). Interior charring is more prevalent on the Subset B Middle Woodland pots as compared to the Early Woodland wares. The data derived from the Subset A and Subset B vessels indicates that the assemblage frequencies are skewed to lower relative frequencies of interior carbonization due to vessel completeness. Using the most complete pots in Subset A, the data further suggest that Early Woodland wares have a higher frequency of interior carbonization than Middle Woodland pots. Based on the Subset B vessels, differential interior carbonization patterning may be present on the Middle Woodland pots as compared to the Early Woodland wares.

Interior carbonization of the Finch vessel assemblage are classified into four distinct patterning types designated as Types 1 through 4 (Figure 5.20). The different types of patterning correlate with different cooking modes. The types are differentiated based on the overall shape of the charring and occurrence on a specific vessel portion. Carbonization shape categories consist of banding that encircles the interior of the vessel and discrete patches of sooting. A qualitative assessment of the abundance of soot patches is further characterized as isolated, few, and numerous. Location of interior carbonization is classed as rim/lip, rim and body (upper and/or middle), and body (upper and/or middle). The co-occurrence of shape type and frequency and location compose the types as displayed in Figure 5.20.

Table 5.40. Comparison of Interior Carbonization Relative Frequencies by Vessel Group

Vessel Category	Early Woodland		Middle Woodland		Total	
	Number of Vessels	Percent	Number of Vessels	Percent	Number of Vessels	Percent
All Vessels	10	37.04	23	51.11	33	45.83
Subset A	8	66.67	13	59.10	21	61.76
Subset B	3	20.00	10	43.78	13	34.21

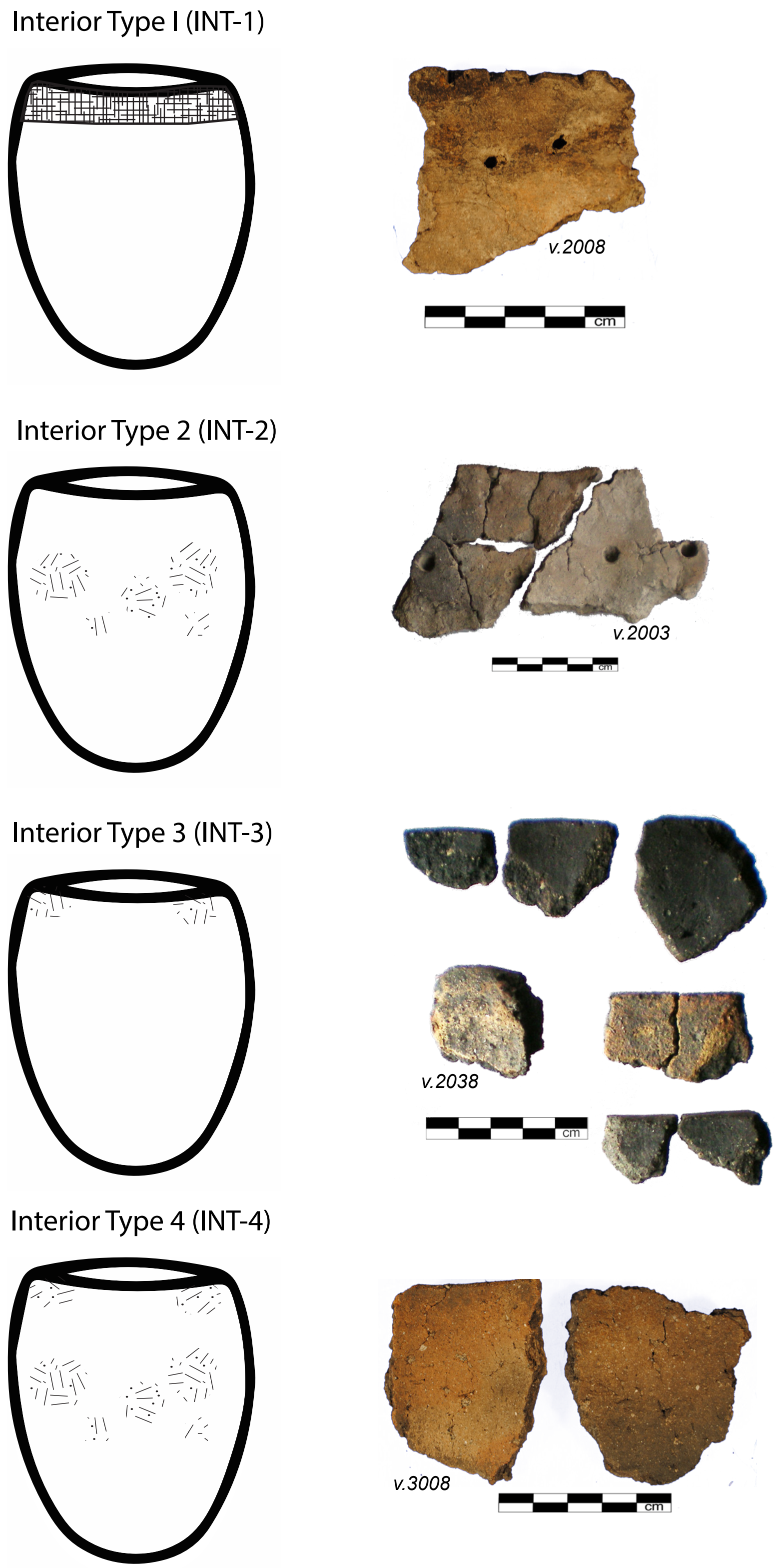


Figure 5.20. Four types of interior carbonization patterning present in the Finch vessel assemblage.

The interior carbonization patterning is assessed only for the more complete vessels in Subset A (Table 5.41). Including the Subset B observations for the delineation of pattering would skew the data, likely resulting in a mis-characterization of the patterning due to the incompleteness of many vessels.

The most common interior carbonization pattern on the Subset A vessels is Type 2, consisting of numerous soot patches on the body (upper and/or mid-vessel) but absent from the rim (Table 5.41). A total of seven vessels exhibit a Type 2 pattern, accounting for 33.33 percent of the assemblage. Following in frequency are Type 1 vessels that represent 28.57 percent (n=6) of the Group A vessels. A band of carbonization encircling the upper portion of the vessel, from the lip margin to the base of the rim, and the presence of numerous soot patches on body sherds defines Type 1. Type 4 is the third most common form of interior carbonization, consisting of a few soot patches on the rim and body. A total of five vessels, or 23.81 percent of the Group A pots, display a Type 4 pattern. Least abundant are Type 3 patterned pots, characterized by an isolated soot patch present only on the interior rim portion of the vessel. Two vessels exhibit a Type 3 pattern, composing ten percent of the Group A vessels.

Table 5.41. Relative Frequency of Interior Carbonization Patterns on Vessels - Subset A

Location	Label	Early Woodland		Middle Woodland		Total	
		Number	Percent	Number	Percent	Number	Percent
Type 1: Carbonization band on rim	INT-1	1	12.50	5	38.47	6	28.57
Type 2: Patches on body	INT-2	3	37.50	4	30.77	7	33.33
Type 3: Isolated patches on rim	INT-3	1	12.50	2	15.38	3	14.29
Type 4: Patches on body and rim	INT-4	3	37.50	2	15.38	5	23.81
Total		8	100.00	13	100.00	21	100.00

Early Woodland vessels exhibit all four types of interior carbonization patterns (Table 5.41). Most common are Types 2 (patches on body) and Type 4 (patches on body and rim), each represented by three vessels. Least common are Type 1 (carbonization band) and Type 3 (isolated patch on rim) patterning, each present on only one vessel. Middle Woodland vessels exhibit each type of patterning. Most prevalent are vessels with Type 1 (carbonization band) patterning, present on six vessels. Type 2 (patches on body) patterning follows in frequency present on four vessels. Type 4 (patches on body and rim) is the next most common type, present on two vessels. Least common among the Middle Woodland vessels, represented by one vessel, is the Type 3 (isolated patch on rim) pattern.

Exterior Sooting, Interior Carbonization, and Cooking Activities

Correspondence analysis is undertaken to more fully understand the relationship between exterior sooting and interior carbonization patterns and to further elucidate specific cooking activities represented by such patterns and interrelationships. For this discussion, only the most complete vessels, those pots in Subset A, that exhibit some form of carbonization are used for the quantitative assessment (Appendix G). The exterior and interior sooting types and labels are provided in Table 5.42.

Correspondence analysis is initially conducted on two qualitative variables, exterior soot location and interior carbonization type, to elucidate their relationship (Figure 5.21). A chi-square (χ^2) yields a value of χ^2=24.014 (p-value 0.004), indicating that it is statistically likely that if a vessel exhibits fire alteration on one side, it is also sooted on the other side (Table 5.43).

Multiple correspondence analysis identifies the total variance from the expected values (values that display no relationship) of the row and columns (Baxter 1994; Greenacre 2007; Shennan 1997; VanDerwarker 2010). The departure from the expected variance is referred to as inertia. Multiple correspondence analysis also determines how many dimensions, or components, explain the variance. For each component (dimension), an eigenvalue is calculated, representing the

Table 5.42. Qualitative Variables Used for the Correspondence Analysis

Description	Label
Exterior Soot	
Type 0: None	EXT-0
Type 1: Rim/Lip	EXT-1
Type 2: Upper Body and/or Body	EXT-2
Type 3: Rim & Upper Body	EXT-3
Interior Carbonization	
Type 0: None	INT-0
Type 1: Carbonization band on rim	INT-1
Type 2: Patches on (upper, mid, lower) body	INT-2
Type 3: Isolated patches on rim	INT-3
Type 4: Patches on rim and (upper, mid, lower) body	INT-4

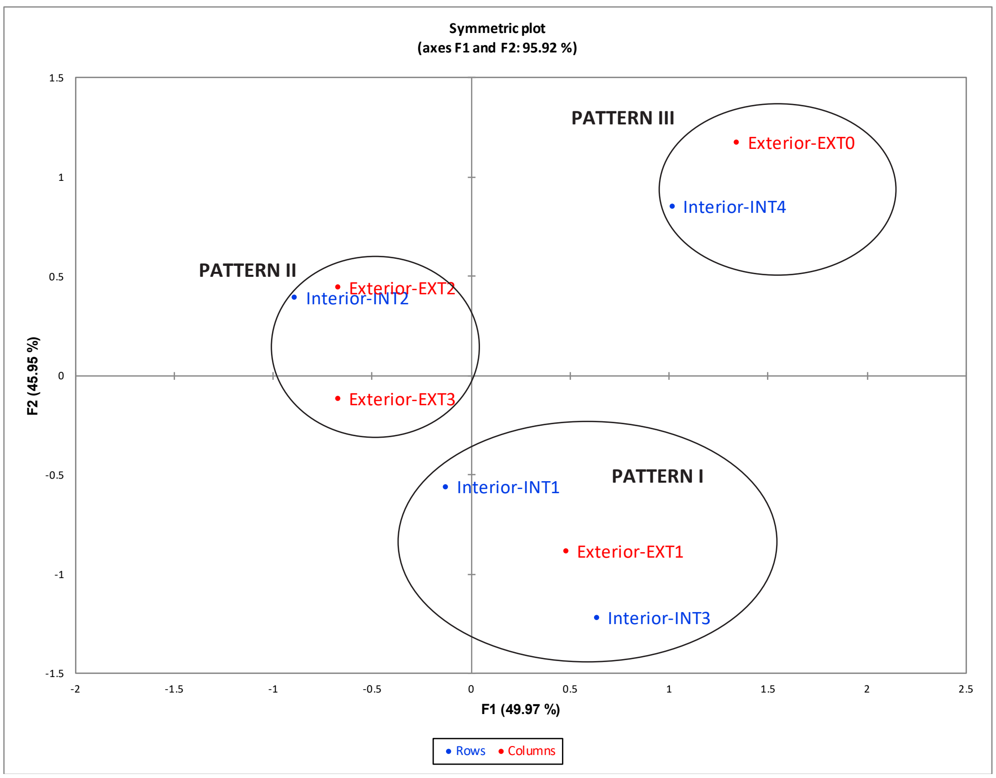


Figure 5.21. Correspondence analysis of exterior sooting location and interior carbonization type, Subset A vessels with carbonization (n=21)

proportion of inertia explained by the associated component (Baxter 1994; VanDerwarker 2010). The eigenvalues for the multiple correspondence analysis of exterior soot location and interior carbonization type indicate that the first two factors explain 95.92 percent of the variance for the plot of interior carbonization and exterior carbonization type (Figure 5.21). The plot of factors one and two reveal three distinct groups, designated as Pattern Types I, II, and III, based on the patterning of interior and exterior sooting. Each group is described below and then correlated with cooking/processing tasks that could account for the soot patterning (Table 5.44).

Pattern Type I indicates that exterior sooting on the lip/rim (EXT-1) tends to co-occur with interior carbonization patches on the lip/rim (INT-3) and an interior carbonization band that encircles the interior rim and upper body vessel portion (INT-1). Interior type 3 (INT-3) carbonization can also include patchy sooting on body sherds. The presence of exterior soot indicates that the vessels were placed directly in a fire. The carbonization band indicates wet mode cooking demarcating the water line (or scum line) of the pot. The vessel walls above this line are able to reach (and exceed)

Table 5.43. Chi-Square Statistic for Exterior Sooting Location and Interior Carbonization Type - Group A Vessels with Use Wear

Description	Value
Chi-square (Observed value)	24.014
Chi-square (Critical value)	16.919
DF	
p-value	0.004
alpha	0.05

Note: Data set is provided in Appendix G temperatures of 300°C permitting charring. Below this line, the liquid contents cool the vessel walls so that they typically do not reach the critical temperature necessary for carbonization. At the water line, starchy and fatty food particles can accumulate and burn in this high temperature zone (Skibo 1992, 2013; Kooiman 2018). However, as interior type 3 (INT-3) vessels exhibit patchy soot beneath the water line, the vessels were likely used for stewing, subjected to heavy use, and/or used for more than one type of cooking. Stewing gradually removes much of the water from the food mix, allowing more food particles to come into contact with the vessel wall and become charred through prolonged exposure (Kooiman 2018). Each of these activities would allow for organic material present in the liquid to absorb into the vessel walls and then char upon subsequent vessel use. The presence of charring on the interior and exterior rim portions suggests spillage or splatter from the manipulation of vessel contents during cooking or serving.

Table 5.44. Activities Represented by the Early and Middle Woodland Vessels (Group A) Based on Exterior Sooting and Interior Carbonization

Group	Activity Type	Interior Carbonization Type	Exterior Sooting	Cooking Type	Cooking Mode	Frequency of Use
Pattern Type I	Multi-functional, wet mode, heavy use	Type 1, Type 3	Present: Lip/Rim (Type 1)	Direct	Wet: Boiling, Stewing	Heavy
Pattern Type II	Multi-functional, roasting or simmering/stewing, light to heavy use	Type 2	Present: Body and/or Rim (Type 2, Type 3)	Direct	Dry (Roasting), Simmering, Stewing (wet)	Light to Heavy
Pattern Type III	Indeterminate (Possible single function, simmering, boiling, stewing; or roasting)	Type 4	Absent	Indirect? Direct?	Indeterminate	Light?

Pattern Type II is characterized by exterior sooting on the mid-body of the vessel (EXT-2 and/or EXT-3) with interior carbonization on the body (upper, mid, lower) but absent from the rim (INT-2). The interior carbonization is patchy and variable, ranging from a few discrete patches to vessels with numerous soot patches. The difference in patch occurrence may reflect intensity or frequency of use and re-use. The lack of banding on the interior, indicative of a scum line, suggests that the vessels were not used for wet-mode cooking such as boiling. Patchy sooting on the vessel body indicates these portions exceeded 300°C and suggestive of dry-mode (roasting) type cooking or stewing. If stewing, the vessel contents were not consistently heated to a high temperature, given the absence of a scum line. During stewing at a low temperature, organic material may have been absorbed into the vessel wall. Subsequent use of the pot for roasting could result in the charring of the organic material that had been previously incorporated into the vessel wall. Dry mode cooking, such as parching or roasting, can deposit thick residues across the vessel surface, although typically concentrated along the bottom or to one side of the pot (Kooiman 2018; Skibo 1992, 2013). The lack of complete vessels hampers a more definitive interpretation; the presence of interior carbonization along the lower body and bottom of the vessel would further support the interpretation of roasting. The presence of exterior sooting further confirming vessel use for cooking by placement directly in a fire and their routine exposure to high heat.

Pattern Type III associates the lack of exterior sooting with interior carbonization occurring as isolated patches on the body and rim (Type 4). The absence of exterior sooting suggests that the vessels were not placed directly on or over a fire, potentially evidencing indirect cooking. However, if the vessels had been used for indirect heating, a scum line would be expected to form as the liquid contents were simmered, stewed, or boiled. Conversely, if these three vessels were used for roasting, exterior sooting would be expected to occur. Two explanations could account for the patterning. If the vessels were used for indirect heating, they were used infrequently so that scum line could not form. Or, if used for direct heating, the vessels were placed in the fire in such a way that only the bottom portion of the vessel was sooted and thus not archaeologically visible on the Finch vessels.

Multiple correspondence examines the relationship of the sooting patterns relative to the Early and Middle Woodland components. The association of three qualitative variables, including component, exterior sooting location, and interior carbonization type, are explored using the Subset A vessels that exhibit fire alteration (Appendix G). The correspondence analysis indicates that factors one and two account for 67.05 percent of the variance (Figure 5.22). The plot indicates the association of Middle Woodland with Pattern Type I vessels. Early Woodland does not cluster near any group, but is closer to Pattern Type II and Pattern Type III than Pattern Type I.

Multiple correspondence analysis explores the relationship between exterior sooting and interior carbonization patterns between vessels classified as Havana ware, Middle Woodland local wares, and Early Woodland pots (Figure 5.23). Based on the most complete vessels (Subset A vessels), the multiple correspondence analysis indicates distinctive patterning based on the types of exterior sooting and interior carbonization by ware type. The strongest patterning occurs with vessels classified as Havana ware. The multiple correspondence analysis associates Havana ware vessels with interior carbonization banding (INT-1) and rim patches (INT-3) and exterior sooting on the lip (EXT-1). These traits are interpreted as Pattern Type I, relating to a multi-functional and heavy pot use using wet mode cooking (boiling and/or stewing). The local Middle Woodland vessels are more similar to the Early Woodland vessels than the Havana ware. The local Middle Woodland wares and Early Woodland vessels are associated with Pattern Types II and III indicative of roasting and/or simmering activities as well as an indeterminate mode of cooking.

Attrition

Linear tool marks and pitting are the attrition types represented in the assemblage and were largely observable on the interior of the vessels. Attrition on the vessel exteriors is rare, occurring on only four vessels, all Middle Woodland pots. Two vessels (v.2005 and 2014) have between one to three small diameter (2-3 mm) pits just below the lip on the exterior of the vessel. Both of these vessels (v.2005 and 2014) also exhibited residue on the exterior lip/rim. Four vessels (v.2005, 2014, 2040, and 3027) exhibit diagonal to horizontal tool marks on the exterior rim, with some

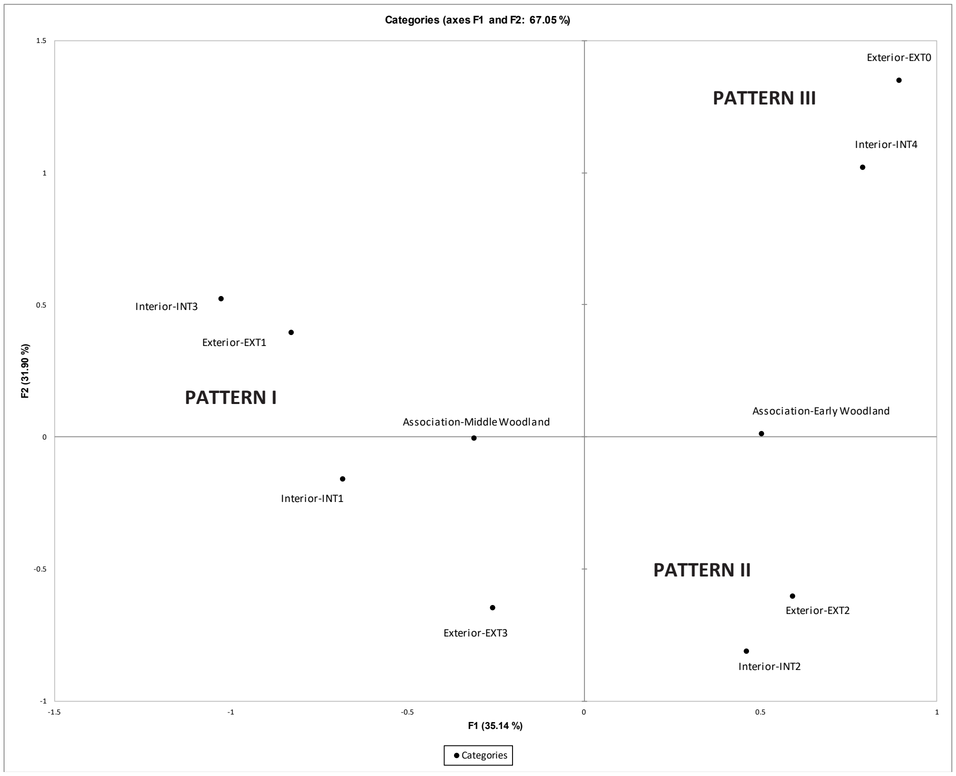


Figure 5.22. Multiple correspondence analysis of exterior sooting location, interior carbonization type, and component (raw data in Appendix G).

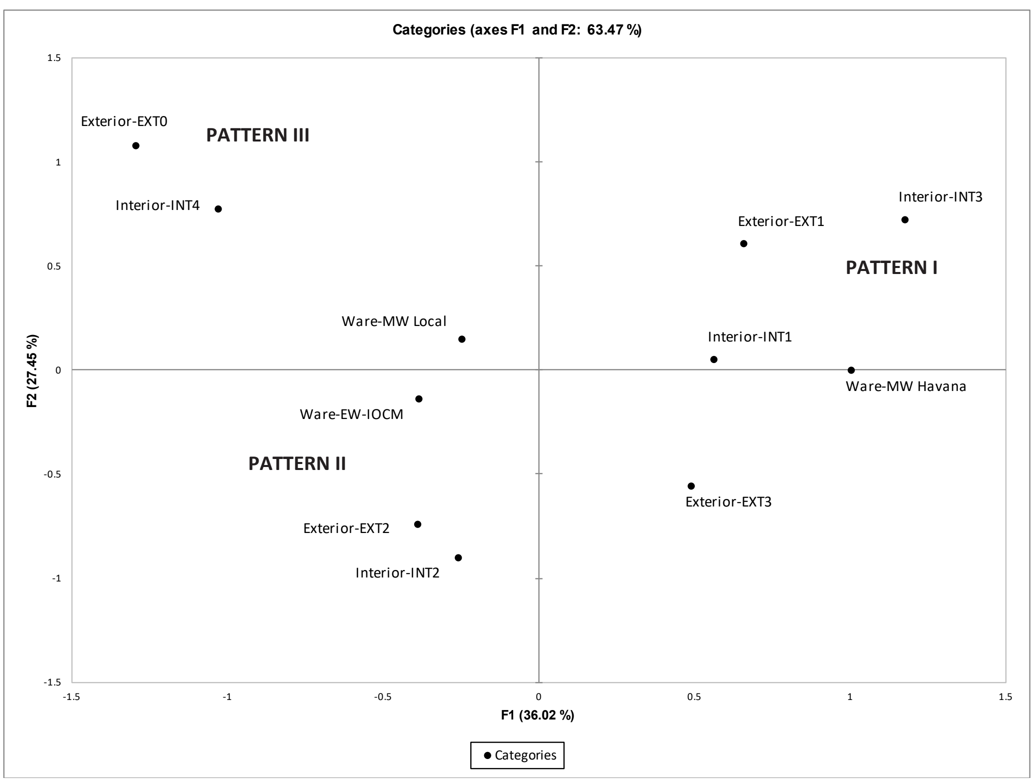


Figure 5.23. Multiple correspondence analysis of exterior sooting location, interior carbonization type, and detailed vessel type (raw data in Appendix G).

extending onto the upper body. The low frequency of attrition on the exterior of the pots likely relates to the vessel portions represented in the assemblage, largely characterized by the middle and upper portions. Few lower body and basal vessels are present in the assemblage; these portions may be expected to exhibit higher frequencies of exterior attrition as compared to other portions of the vessel. For example, manipulation of a vessel within a hearth or during cleaning may result in scratches and pedestaled temper in bottom regions of the vessel (Skibo 1992; 2013).

Attrition observable on the interior of the vessel is more prevalent, present on just over one-half of the vessels (Table 5.45). Early and Middle Woodland vessels exhibit similar frequencies of attrition, with the Early Woodland pots exhibiting a slightly higher relative frequency of attrition. Attrition on the interior consists of linear tool marks and pits, with linear tools much more prevalent than pitting (Table 5.46).

As linear tool marks represent tool use, reflecting direct manipulation of the vessels contents, the patterns of association between the presence or absence of linear tools marks, exterior sooting, and interior carbonization are explored using multiple correspondence analysis (Figure 5.24). The analysis includes all of the Subset A pots exhibiting some form of use wear, inclusive of the 21

Table 5.45. Comparison of Exterior and Interior Attrition Relative Frequencies - All Vessels

Component	Total Number of Vessels	Number	Percent
Early Woodland	27	15	55.56
Middle Woodland	45	24	53.33
All Vessels	72	39	54.17

Table 5.46. Number and Relative Frequency of Interior Attrition Types - All Vessels

Type of Attrition	Early Woodland n=15		Middle Woodland n-24		Total n=39	
	Number	Percent	Number	Percent	Number	Percent
Linear Tool	10	66.67	20	83.33	30	76.92
Linear Tool & Pitting	3	20.00	3	12.50	6	15.38
Pitting	2	13.33	1	4.17	3	7.70
Total	15	100.00	24	100.00	39	100.00

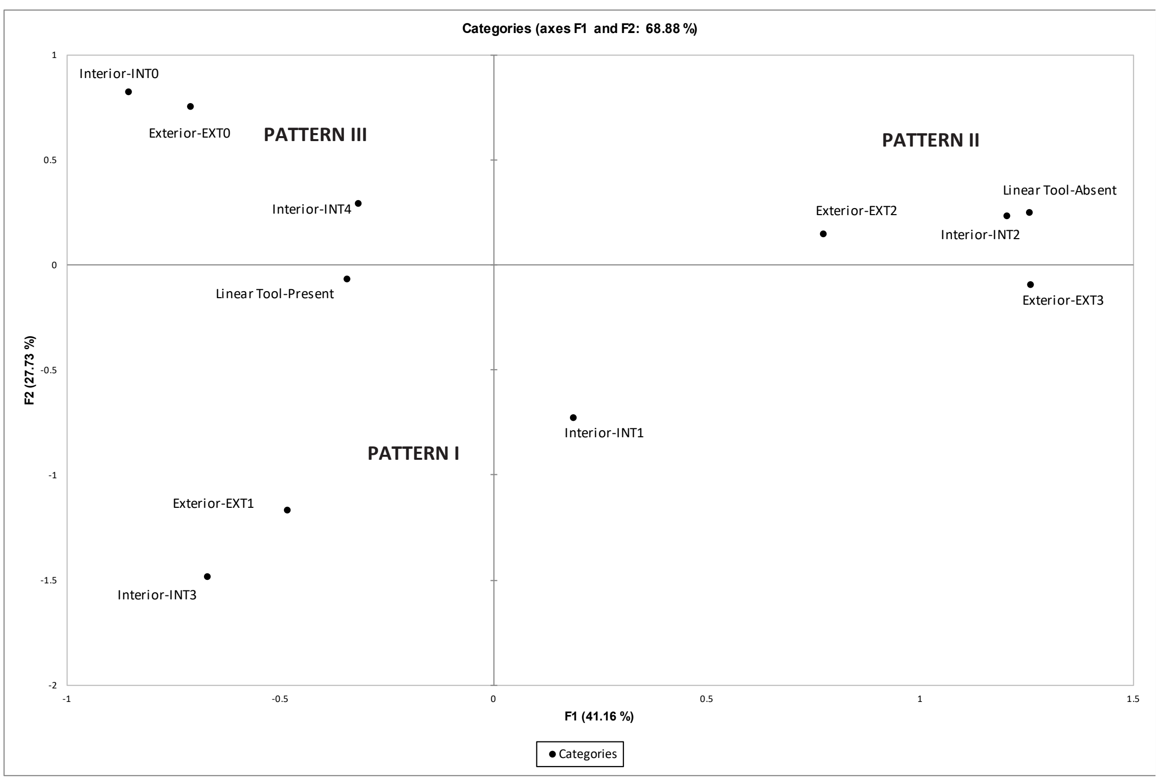


Figure 5.24. Multiple correspondence analysis of interior linear tool presence, exterior sooting location, interior carbonization type (raw data in Appendix G).

vessels exhibiting some form of carbonization and seven vessels exhibiting linear tools marks as the sole form of use ware. The multiple correspondence analysis associates the presence of linear tool marks with Pattern III, reflective of an indeterminate mode, and Pattern Type I, indicative of boiling or stewing. The association of linear tools marks with Pattern Type I concords with the interpretation that these pots were heavily used. The absence of linear tools associates most closely with Pattern Type II pots, interpreted as used for roasting or simmering/stewing and not as heavily used as compared to the Pattern Type I pots. The correlation of linear tools with carbonization patterns suggests that Pattern Type I and III pots were more actively attended during cooking as compared to the Pattern Type II pots. The data also indicate that the pots lacking any carbonization were also heavily manipulated during cooking and/or serving activities.

Actual Function: Lipid Residue Analysis

Upper body and rim sherds from 13 vessels were submitted to the Archaeological Residue Analysis Laboratory at Brandon University for chemical residue lipid analysis (Appendix H to Appendix J). The vessels include five Early Woodland jars (vessels 3007, 3015, 3018, 3021, and 3022), four Middle Woodland Havana ware vessels (vessels 2001, 2002, 2004, and 3034), and four local Middle Woodland forms (vessels 2003, 2014, 2017, and 2019). An overview of the results for the 13 vessels is detailed below, followed by a discussion of the lipid residue results by component and observed use-wear patterns.

Of the 13 vessels submitted for analysis, 12 vessels yielded sufficient lipid residues for identification (Malainey and Figol 2017, 2019). One Early Woodland vessel (vessel 3021) contained insufficient fatty acids for identification. Identified lipid categories for the vessel sub-set include herbivore and plant, herbivore only, decomposed nut oil and plant, medium fat content animal and plant, lot fat content plants, medium-low fat content plant, and plant only (Table 5.47, Table 5.48).

Table 5.47. Known Food Sources for Identified Decomposed Residue

Decomposed Residue Identification	Plant Foods Known to Produce Similar Residues	Animal Foods Known To Produce Similar Residues
Large herbivore	Tropical seed oils, including sotol seeds	Bison, deer, moose, fall-early winter fatty elk meat, Javelina meat
Large herbivore with plant PR Bone Marrow	--	--
Low Fat Content Plant (Plant greens, roots, berries)	Jicama tuber, buffalo gourd, yopan leaves, biscuit root, millet	Cooked Camel's milk
Medium-Low Fat Content Plant	Prickly pear, Spanish dagger	None
Medium Fat Content (Fish or Corn)	Corn, mesquite beans, cholla	Freshwater fish, Rabdotus snail, terrapin, late winter fat-depleted elk
Moderate-High Fat Content (Beaver)	Texas ebony	Beaver and probably raccoon or any other fat medium-sized mammals
High Fat Content	High fat nuts and seeds, including acorn and pecan	Rendered animal fat (other than large herbivore), including bear fat
Very High Fat Content	Very high fat nuts and seeds, including pine nuts	Freshly rendered animal fat (other than large herbivore)

Note: Adapted from Malainey and Figol 2017, 2019.

Table 5.48. Identified Lipid Residue by Category and Component

Lipid Category	Early Woodland		Middle Woodland (Local)		Middle Woodland (Havana)		Total	
	Number of Vessels	Percent	Number of Vessels	Percent	Number of Vessels	Percent	Number of Vessels	Percent
Decomposed nut oil and plant	--	--	1	25.00	--	--	1	7.69
Herbivore and plant	2	40.00	3	75.00	3	75.00	8	61.54
Herbivore only	1	20.00	--	--	--	--	1	7.69
Medium fat animal & plant	1	20.00	--	--	--	--	1	7.69
Plant only	--		--	--	1	25.00	1	7.69
Indeterminate	1	20.00	--	--	--	--	1	7.69
Total	5	100	4	100.00	4	100.00	13	100.00

Lipid Category: Herbivore and Plant

Based on relative frequencies, the majority of vessels (n=8; 61.54 percent) yielded evidence of absorbed residues indicative of both herbivores and plants. The residue identification indicates that large herbivores were concurrently prepared along with plant foods in these vessels or that other types of plant foods were prepared in the pots that were also used to cook large herbivore meat (Malainey and Figol 2019). Although these eight vessels yielded decomposed residues that are broadly similar, the patterning of plant and animal biomarkers and triglycerols suggests some differences in the types of foods prepared in the pots. Accordingly, the herbivore and plant category is further subdivided into four sub-types consisting of large herbivore with plant roots (n=4), large herbivore and medium fat content foods (n=1), large herbivore and low fat content (n=1), and complex composition (n=1) (Table 5.49). Each of these sub-categories is further described below.

Table 5.49. Sub-Categories of the Vessels with Decomposed Residues Identified as Herbivore and Plant

Herbivore and Plant Sub-Type	Early Woodland	Middle Woodland (Local)	Middle Woodland (Havana)
Large herbivore with plant roots	V.3018 (IOCM)	V.2014 (Shorewood Cord Roughened) V.2019 (Deer Creek Incised)	V.2001 (Havana Zoned)
Large herbivore & medium fat content	V.3015 (IOCM)	--	--
Large herbivore & low fat content	--	V.2003 (Shorewood Cord Roughened)	--
Complex composition	--	--	V.2004 (Naples Stamped)
Large herbivore (marbled) & plant	--	--	V.2002 (Havana Zoned)

Residues identified as large herbivore with plant roots were detected in four vessels including an Early Woodland IOCM jar (v.3018), a Middle Woodland Shorewood Cord Roughened jar (vessel 2014), a Havana Zoned vessel (v.2001), and Deer Creek Incised vessel (v.2019). The fatty acid signature for the Early Woodland jar (v.3018) indicates that the animal may have been taken in mid-late winter (January - February) when it was fat-depleted. Faunal remains identifiable to taxon recovered in association with these four vessels consist of medium/large mammal, turtle (Testudines), and fish. Plant macroremains are associated with the two vessels recovered from feature contexts, the Havana Zoned vessel (v.2001 in feature 96) and the Deer Creek Incised vessel (vessel 2019 in features 74 and 75). The plant macroremains are identified as squash (*Cucurbita* sp.) rind, hickory (*Carya* sp.) nutshell, walnut (Juglandaceae) nutshell, bedtraw (*Galium* sp), and wood charcoal.

Large herbivore and medium fat content food residue was identified from a single vessel, an Early Woodland IOCM jar (v.3015) recovered from a unit context. Residue was detected indicating large herbivore as well as medium fat content foods that are derived from plant and/or animal sources (Table 5.47). The conifer biomarker was also identified in the fatty acid residue. Faunal remains were recovered from the unit containing vessel 3015 but none are identifiable. Plant macroremains from the unit context consist solely of wood charcoal.

Large herbivore and low fat content plant residue was identified from a single vessel, a Middle Woodland Shorewood Cord Roughened jar (v.2003) recovered from a unit context. The conifer biomarker was also identified in the residue. No plant macroremains and/or faunal remains are directly associated with the vessel.

A Havana ware vessel, Naples Stamped (vessel 2004) produced a complex composition indicative of large herbivore with plant or bone marrow. The residue profile indicates either the presence of large herbivore bone marrow and low fat content plant products or a combination of large herbivore meat, medium fat content foods (plant and animal), and low fat content plants. The conifer biomarker was also identified in the residue profile. Vessel 2004 was recovered from a unit context. No faunal remains and/or plant macroremains were recovered from the unit and in association with the vessel.

A single vessel, a Havana zoned vessel (vessel 2002) yielded large herbivore with marbled meat and plant residue (Malainey and Figol 2017). The vessel was recovered from a cooking pit, feature 114, that yielded numerous faunal remains identified as fish, turtle, and medium/large mammal. Plant macroremains from the feature include bitternut hickory (*Carya cordiformis*), acorn (*Quercus* sp.), and walnut family (Juglandaceae) nutshell. Vessel 2017 was (see below) was also recovered from the feature.

Lipid Category: Decomposed Nut Oil and Plant

Decomposed nut oils and plant residues was identified in a single vessel, a local Middle Woodland Shorewood Cord Roughened jar (vessel 2017). The lipid biomarkers indicate decomposed nut oil, low fat content plants, and lean large herbivore, indicating that multiple plant and animal resource types were prepared in the vessel. The low fat content plants include types such as roots, greens, starchy seeds, and berries. The conifer biomarker was also identified in the residue. Vessel 2017 was recovered from a cooking pit (feature 114) that yielded numerous faunal remains identified as fish, turtle (Testudines), and medium/large mammal. Plant macroremains from the feature include bitternut hickory (*Carya cordiformis*), acorn (*Quercus* sp.), and walnut family (Juglandaceae) nutshell.

Lipid Category: Herbivore

Residue limited to just herbivores was identified in a single vessel, an Early Woodland Dane Punched jar (vessel 3022) recovered from a cooking pit (feature 110). Calcined faunal remains were recovered from the feature, however, none are identifiable. Despite numerous flotation samples, no plant macroremains were recovered from the feature, thus concording with the residue data that lacks evidence of plants.

Lipid Category: Medium Fat Animal and Plant

Medium-fat content animal and plant residue was identified in a single vessel, an Early Woodland IOCM jar (vessel 3007) recovered from a unit context. The fatty acids indicates a combination of large herbivore meat and medium fat content residues. Associated faunal remains from the unit are identified as mammal.

Lipid Category: Plant Only

A Havana ware vessel, vessel 3034, did not yield sufficient fatty acids for identification. However, the signature for plant sterol was present suggesting that the vessel may have been used to store plants (Malainey and Figol 2019). The vessel was recovered from a unit context and is associated with faunal remains and plant macroremains. Faunal remains recovered from the unit are identified as mammal and reptile. Plant macroremains from the unit include nutshell (all unidentified) and rhizomes.

Conifer Biomarker

The conifer biomarker was identified in five vessels, including two Early Woodland IOCM jars (vessels 3007 and 3015), two Shorewood Cord Roughened vessels (vessel 2003 and 2017), and a Naples Stamped jar (vessel 2004). The conifer product has been identified within a small subset of Late Woodland vessels from the Cloudman site in the Upper Peninsula of Michigan (Kooiman 2018). Pine resin may have been applied to the interior of the vessel to reduce permeability, as known from precontact pottery from New York and among modern pottery-producing societies using low-fire, unglazed wares (Kobayashi 1994; Kooiman 2018; Skibo 2013).

Lipid Residue Patterning by Component

Early Woodland vessel residues are identified as herbivore, plant roots, medium fat content plant or animal, and plant only (Table 5.50). The five Early Woodland vessels yielded three different lipid residue signatures consisting of herbivore and plant (vessels 3018 and 3015), herbivore only (vessel 3022), and medium fat animal and/or plant (vessel 3007). One vessel (vessel 3021) did not yield sufficient residue for identification but produced plant and animal biomarkers (Malainey and Figol 2017). The two vessels with herbivore and plant residue include a vessel with large herbivore with plant roots (vessel 3018) and large herbivore with medium fat content plant or animal (vessel 3015).

Middle Woodland residues are identified as herbivore, plant roots, decomposed nut oil, and plant (general) (Table 5.50). The four local Middle Woodland vessels evidence two types of lipid residue profiles indicative of herbivore and plant (n=3) and decomposed nut oil and plant (n=1). The three vessels with herbivore and plant residue include two vessels (vessel 2014 and 2019) with large herbivore and plant roots and one vessel (vessel 2003) with large herbivore and low fat content plant indicators.

Table 5.50. Lipid Residues Identifications by Component

Lipid Type (Ingredient)	Early Woodland Vessel	Middle Woodland (Local) Vessel	Middle Woodland (Havana) Vessel
Herbivore	Present	Present	Present
Herbivore (bone marrow)	--	--	Possible
Plant - General	Present	Present	Present
Plant Roots (Low Fat Content)	Present	Present	Present
Medium-Low Fat Content Plants	--	--	Possible
Decomposed Nut Oil	--	Present	--
Medium Fat Content Animal/Plant	Present	--	--

Havana ware residues are identified as herbivore, herbivore-bone marrow (possible), plant roots, medium-low fat content plants, and plants (general) (Table 5.50). Of the four Havana ware Middle Woodland vessels, three vessels yielded one type of residue profile consisting of herbivore and plant. Residue from these three vessels are further described as: herbivore with plant roots (vessel 2001); a complex composition that indicates either the presence of large herbivore bone marrow and low fat content plant products or a combination of large herbivore meat with low/medium fat content plants (vessel 2004); and herbivore (marbled) with plants (vessel 2002). As noted above, one Havana ware vessel (vessel 3034) lacked enough residue for identification, but produced the biomarker for plants.

The residue analysis demonstrates that nearly all vessels, across all components, were used for food preparation and cooking tasks involving animals, especially large herbivores, and plant material. The residue analysis thus concords with the use wear analysis that concluded most Early and Middle Woodland pots were used for multiple functions with use intensity ranging from heavy to light. The use wear analysis further revealed the lack of clear patterning for many pots, which is supported by the residue analysis that shows a wide variety of residue profiles.

There are, however, a few notable differences in the residue profiles of the Early Woodland, local Middle Woodland, and Havana ware vessels. Two Early Woodland vessels yielded medium fat content plant or animals that were not detected in the Middle Woodland vessels. Medium fat content lipid profiles related to corn and fish; as corn is an unlikely candidate for an Early Woodland vessel, the residue may relate to fish. The local Middle Woodland vessel yielded the only evidence of nut oil; this lipid category was absent from the Early Woodland vessels and the Havana ware vessels. Finally, the Havana ware vessels produced evidence of herbivore bone marrow and medium-low fat content plants that are absent from the Early Woodland and local Middle Woodland vessels. Moreover, in one Havana ware vessel, the herbivore signature is noted as “nicely marbled” (Malainey and Figol 2017; Appendix I) indicating that a higher quality cut of meat was prepared in the vessel.

Finally, there are three vessels that evidence singular animal or plant profile: an Early Woodland Dane Punched vessel (vessel 3022) producing herbivore residue; decomposed nut oil and plant residue present in one vessel, a Middle Woodland Shorewood Cord Roughened vessel (vessel 2017); and a plant only marker present in a Middle Woodland Havana Zoned jar (vessel 3034). Each of these vessels yielded a use pattern classified as Pattern Type II, indicating that differing types of foods may have been prepared and/or cooked in a similar manner.

Summary

This chapter presents the ceramic analysis conducted on the Early and Middle Woodland Finch ceramic assemblage employing morphological and functional approaches to address aspects of each of the five research questions. The data is detailed in this chapter and interpreted, relative to the research questions, in Chapter 7, in order to integrate the ceramic results with the plant macroremains and faunal assemblage data (Chapter 6).

The archaeological excavations at the Finch site yielded a substantive ceramic assemblage consisting of over 9,000 sherds and 72 discrete vessels (Picard and Haas 2019). The attribute analysis describes the morphological characteristics of the ceramic vessels relative to aspects of morphology, manufacture, decoration. All of the vessels are jars and mostly grit-tempered, although a few sand-tempered Early Woodland vessels are present in the assemblage. Middle Woodland vessels tend to be larger with thicker walls as compared to the Early Woodland pots. A variety of decorative forms are represented in the assemblage. The most common decorative modes for Early Woodland pots is incising and for the Middle Woodland vessels, nodes/bosses are the most prevalent.

Given the Finch site context as a domestic habitation, the ceramic vessels recovered from the site almost certainly had a culinary related function and are directly associated with cooking-related activities (Kooiman 2016; McPherron 1967; Janzen 1968; Brose 1979; Fournier 2007; Rice 1987).

These cooking vessels may have been used for different methods of cooking, for cooking different food types, or for cooking within distinct domestic or ritual contexts (Kooiman 2016), and thus directly representative of culinary traditions and foodways.

The use wear study identifies the intended and actual use of individual vessels through macroscopic techniques and chemical analyses. Although all of the vessels from the Finch site are jars and designed for cooking, vessel attributes relating to manufacture indicate that various jar forms were designed to be used for different types of cooking related tasks. The small, thin walled globular vessels may have been used for rapid heating, with vessel contents allowed to come to a boil quickly. The larger conoidal vessels, with thicker walls, were manufactured for lower temperature and longer term cooking, such as simmering. Contents within both the globular and conoidal vessels were easily accessible during cooking. The neckless jar form, represented by a single vessel in the assemblage, was designed for rapid heating but had restricted accessibility during cooking, thus distinct from the globular forms with unrestricted orifices.

Actual function is assessed through macroscopic characteristics of sooting, interior carbonization, and attrition, as well as chemical residue analysis. Exactly one-half the Early and Middle Woodland vessels from the Finch site display evidence of fire-alteration consisting of exterior sooting and/or interior carbonization. The Middle Woodland vessels have a higher relative frequency of fire use alteration as compared to the Early Woodland vessels. A relatively small percentage of the vessels exhibit sooting, providing direct evidence of the use of the pots over a fire or coals for cooking and/or processing tasks. Early and Middle Woodland vessels exhibit similar frequencies of exterior sooting. Exterior sooting patterning, however, differs by component, with Middle Woodland pots tending to have soot near the rim/lip and on the body/upper body for Early Woodland pots. Just under one half of the Finch vessels exhibit interior carbonization with Early and Middle Woodland pots exhibiting similar relative frequencies of occurrence.

As completeness of the vessels affects the patterning of exterior and interior carbonization, the vessels are categorized into two groups based on completeness. The more complete vessels (Subset A) are then subjected to further analysis. Based on the Subset A vessels, exterior sooting is present on just over one-half of the Early and Middle Woodland vessels. Exterior sooting is more prevalent on Early Woodland wares as compared to the Middle Woodland wares. For the assemblage, exterior sooting is most common on the vessel body, followed by the rim/lip, and is least frequent on both the rim and body. Early Woodland wares tend to have exterior sooting on the body but also occurs, in lower relative frequencies, on the rim/lip and the rim/upper body. Middle Woodland vessels have the highest relative frequency of exterior sooting on the rim/lip but is also present, in slightly lower frequencies, on the rim/upper body and body.

Interior carbonization is present on just over sixty percent of the Subset A vessels. Middle Woodland pots have a lower relative frequency of interior carbonization than the Early Woodland wares. Four patterning types of interior carbonization patterning are identified in the assemblage based on shape, frequency, and vessel portion location. All four patterning types are expressed on the Early and Middle Woodland vessels, although in different relative frequencies. Early Woodland vessel have high frequencies of Type 2 (patches on body) and 4 (patches on body and rim) patterning. Middle Woodland wares exhibit, most frequently, Type 1 (carbonization band) and Type 2 (patches on body) patterning.

Statistical analyses indicate a significant relationship between exterior carbonization and interior charring. If a vessel exhibits fire alteration on one side, it is also sooted on the other. Multiple correspondence analysis using exterior soot vessel location and interior carbonization vessel location delineate three distinct pattern types that correlate to specific cooking/processing tasks. Pattern Type I, marked by an interior carbonization band near the rim and exterior sooting, including residue, near the lip/rim and patch on the body, defines pots that were heavily used for boiling and/or stewing. Pattern Type II pots exhibit patchy interior carbonization and exterior sooting on the body, but absent from rim, and were used for roasting and/or stewing activities.

The Pattern Type II pots were not as heavily used as the Pattern Type I pots. Finally, the Pattern Type III pots exhibit patchy interior carbonization on the rim and body, but lack exterior sooting. Cooking types represented by the Pattern Type III vessels are unclear, but may have been used for indirect cooking or for light use simmering, stewing, and/or roasting. Multiple correspondence analysis associates Pattern Type I pots with the Middle Woodland component and Early Woodland pots as more closely associated with Pattern Type II and Pattern Type III pots. The multiple correspondence analysis of interior carbonization and exterior sooting patterning, and ceramic ware types revealed that Early Woodland and local Middle Woodland wares are more similar to each other than the Havana wares and relate more closely with Pattern Type II and III. The Havana wares are most closely associated with Pattern Type I.

Attrition patterns of the Finch vessels are mostly confined to the interior of the vessels and occurs on just over one half of vessels. Exterior attrition is present on five vessels. The low frequencies of exterior attrition may be related to the completeness of the vessels. Multiple correspondence analysis based on fire alteration patterning and the presence/absence of interior tools marks indicates that Pattern Type I and III vessels are most closely associated with the presence of linear tool marks. The association of linear tool marks with Pattern Type I concords with the interpretation that they were heavily used. Pattern Type II vessels typically lack linear tool marks, suggesting that they were not used as heavily and/or were used in a different manner.

Lipid residue analysis suggests that Early Woodland, local Middle Woodland, and Havana wares were similarity used for variety of food preparation and cooking involving herbivores and plant processing. The residue analysis concords with the use wear analysis that concluded most Early and Middle Woodland pots were used multiple functions with use intensity ranging from light to heavy. There is lack of differentiation, based on residue profiles, between the Early Woodland, local Middle Woodland, and Havana Middle Woodland vessels.

CHAPTER 6: PLANT MACROREMAINS AND ZOOARCHAEOLOGICAL REMAINS

Introduction

This chapter presents the analysis of the plant macroremains and zooarchaeological remains associated with the Early and Middle Woodland components at the Finch site. The chapter builds upon the plant macroremain and zooarchaeological data collected for the cultural resource management project (Haas 2019) and the faunal study completed by Stencil (2015). The chapter begins with a review of the methods employed for the plant macroremain and zooarchaeological analyses conducted as part of this dissertation project. The ecological setting of the Finch site, a brief summary of ethnohistoric use and processing of plant resources, and a description of the samples and seasonality is then provided to establish a context for the recovered archaeological plant and animal specimens. The plant macroremain and zooarchaeological assemblages are fully described and formally compared for the Early and Middle Woodland components at the Finch site. This discussion first focuses on ingredients and then addresses cooking/processing activities represented by the data. The chapter concludes with a narrative describing the overall diversity of the Early and Middle Woodland plant and animal assemblages.

Methods

The methods of analysis are presented below for the plant macroremains and the faunal remains.

Plant Macroremains

Plant macroremains recovered from the Finch site were identified and described as part of the cultural resource management project, providing a basic suite of qualitative and quantitative data on a site-wide basis (Haas 2019). The assemblage includes high frequencies of wood charcoal and nutshell, squash, and wild seeds. This dissertation project conducts new quantitative analyses on the plant macroremain data derived from the main Early and Middle Woodland activity areas.

The new analyses characterize the assemblage, for each component, through abundance measures, ubiquity values, ratios, box plots, and diversity indices (Adams and Smith 2011; Cleveland 1994; Hastorf 1999; Hubbard 1976; Kintigh 1984, 1989; Marston 2014; McGill et al. 1978; Miller 1988; Pearsall 2015; VanDerwarker and Peres 2010; Popper 1988; Reitz and Wing 2008; Scarry 1986; Scarry and Steponaitis 1997; VanDerwarker 2003; VanDerwarker et al. 2014 Wilkinson et al. 1992).

Recovery and Preservation Bias

Cultural and natural processes determine what plants are deposited in the archaeological record and which of those are preserved (Scarry 1986). Only a fraction of the plants used at a site become part of the archaeological record. Preservation conditions, plant characteristics, food processing techniques, and refuse disposal practices are all factors that contribute to the types of plant remains that may be present within an archaeological deposit (Scarry 1986; VanDerwarker et al. 2016).

The circumstances under which plants preserve best archaeologically typically involve extreme conditions that prohibit decomposition of organic matter (Hastorf 1999; Pearsall 1988). Plants can also preserve through the exposure to fire which transforms the plant material from organic matter into carbon (Miksicek 1987; Pearsall 1988; VanDerwarker 2014). Carbonized plant material is subject to mechanical damage, caused by processes such as trampling, repeated wetting/drying, or freezing/thawing.

The probability for plant carbonization varies according to plant type, processing techniques and use, and structural characteristics (Scarry 1986; VanDerwarker 2003). Plants eaten whole are less likely to produce discarded portions that may become carbonized through exposure to fire. Plants requiring the removal of inedible portions (such as hickory nuts and maize cobbs) are more prone to carbonization and typically better represented in the archaeological record (Gallagher 2014; Pearsall 2015; VanDerwarker 2003). Physical characteristics affect plant survivability in a fire. For example, large, dense nutshells are more likely to survive a fire as compared to smaller, more fragile grass seeds. Food processing activities also affect the probability of carbonization. Cooking provides a chance for plant carbonization through accidents. Foods consumed raw are not afforded a similar opportunity and less likely to be deposited in fires (VanDerwarker 2003). Some carbonized plants in the archaeological record were not eaten, such as wood fuel, and other non-food plants that become carbonized represent incidental inclusions (Gallagher 1988; Miksicek 1987; Minnis 1981; Pearsall 1988, 2015; Scarry 1986; VanDerwarker 2003).

Although uncarbonized plant remains are present within the samples, only carbonized plant materials were collected and identified from Finch (Haas 2019). Previous studies demonstrate that uncarbonized materials are rarely preserved at open-air sites in temperate environments (Asch and Asch 1985; Egan 1988). Typically only in water logged or special chemical environments are uncarbonized plant remains preserved in the Midwest (Asch and Asch 1985). Brown and Green (2012:161) note that some uncarbonized and partially uncarbonized seeds may also be considered part of the archaeological assemblage if certain criteria are met, including: (1) seeds containing a high mineral content (such as fruit seeds) in archaeological assemblages under 200 years old; (2) plant specimens recovered from moderately to deeply buried contexts; and (3) lack of concordance between the archaeologically recovered plant remains and plant cover at the time of archaeological excavation. As none of these criteria are met for the Finch site, only carbonized seeds are considered as part of the Finch site archaeological assemblage. For the Finch site, the occurrence of small uncarbonized seeds in subsurface deposits reflects an accumulation by tumbling down pores in the soil or transport by soil fauna, rather than deposition from prehistoric activities (Asch and Asch 1985).

Despite the preservation and recovery biases, the most frequently used plant resources by any past group are more susceptible to activities that result in carbonization, typically via fuel use, accidental burning, and deposition (Gallagher 2014; Pearsall 1988; Scarry 1986; VanDerwarker 2003; Yarnell 1982). As such, it is possible to quantitatively examine the relative importance of commonly used plant resources across time and space (VanDerwarker 2003).

Field Recovery, Laboratory Processing, and Initial Identification

The field recovery, laboratory process and identifications described below were completed prior to this dissertation project as part of the cultural resource management project (Haas 2019). This dissertation project conducts new analyses on the data generated by the previous investigations, restricted to the Early and Middle Woodland Finch site contexts. The narrative below provides a summary of the field and laboratory techniques that generated the Finch site plant macroremain data for full transparency of potential recovery biases.

Plant remains were collected during the archaeological excavations largely through the selection and processing of flotation samples, although a number of charred plant remains were also recovered from the ¼-inch dry screen, the 1/16-inch water screen, and hand picked/piece plots (Haas 2019). Flotation samples were collected from all features, including suspected features, and a percentage of the unit level matrix. Most flotation samples collected from the site were processed with a SMAP forced water flotation tank equipped with an air compressor to help froth the water/soil mixture (Watson 1976). A few flotation samples, recovered from five features excavated in 2012 (Features 161, 164, 165, 167, and 168) were processed using a hand pump system (Shelton and White 2010). In both systems, the light fraction flotation samples were recovered in 0.04 millimeter mesh and heavy fraction samples were collected with an 0.08 millimeter mesh.

All charred plant and wood remains, recovered from flotation and non-flotation contexts, were subjected to further analysis. Initial identification of the plant macroremains was completed by Jennifer R. Haas and Jennifer Picard as part of the cultural resource management project (Haas 2019). Throughout the laboratory process the flotation light and flotation heavy fractions, and the plant remains from non-flotation contexts, are kept separate. The flotation light fraction and heavy fraction are combined for analysis. However, the plant remains from non-flotation contexts are treated independently of the flotation recovered data during the analysis due to issues of comparability (Pearsall 2015).

After flotation processing and drying, both the heavy fraction and light fraction, and plant remains from non-flotation contexts, are passed through a 2.0 millimeter brass geologic sieve. All charred botanical material from the greater than 2.0 millimeter size grade is sorted into wood, nut, squash rind, corn, seed, and other categories. The nutshell and seeds are identified to family and, if possible, to genus. Each taxa is then counted and weighed. The material in the smallest size grade (<2.0 mm) is scanned under a binocular microscope (10X-30X). All charred seeds and seed fragments from this size grade are removed, identified, and tabulated. Although the presence of wood, nut, resin, and amorphous fragments are recorded, these types of fragments are not removed, quantified, or examined as such small fragments generally can not be identified.

Identifications are made with the aid of standard manuals and in reference to comparative specimens in the UWM Archaeological Research Laboratory (Delorit 1970; Martin and Barkley 1961; Minnis 2003; Montgomery 1977; USDA 2017). Nut fragments are identified by comparison of general morphological traits to examples in the reference collection. Seeds are identified by comparison of characteristics such as size, shape, details of the surface, hilium shape and placement, and embryo type. No identifications to the level of species are made as such refined determinations of taxa can be made only if all other possible species of the genus have been eliminated by a direct comparison of morphology.

Taxonomic identification is not always possible as some plant specimens lack diagnostic features altogether or features that are difficult to discern. As a result, these specimens are classified as unidentified seed, unidentified nut, or unidentified plant material. In other cases, probable identifications are provided but a clear taxonomic distinction is not possible, often due to fragmentation. These cases are recorded with a "cf" in front of the taxonomic designation.

Following sorting and identification, counts, weight (grams), portion of plant, and provenience information are recorded. Wood is weighed and counted but no wood identification is undertaken. All collected data is inputted into a Microsoft Access database that is linked to the site GIS model.

Analytical Techniques

This dissertation project conducts new quantitative analyses on the plant macroremains identified by the previous cultural resource management investigations, using the data from the Early and Middle Woodland contexts at the Finch site. The analytical methods employed during the dissertation project consist of abundance measures, ubiquity values, ratios, box plots, and diversity indices (Adams and Smith 2011; Cleveland 1994; Hastorf 1999; Hubbard 1976; Kintigh 1984, 1989; Marston 2014; McGill et al. 1978; Miller 1988; Pearsall 2015; VanDerwarker and Peres 2010; Popper 1988; Reitz and Wing 2008; Scarry 1986; Scarry and Steponaitis 1997; VanDerwarker 2003; VanDerwarker et al. 2014 Wilkinson et al. 1992). A summary of the formulas used as part of the analysis are included as Appendix K.

Abundance

The most common methods for quantifying and recording plant remains is the absolute count and weights of each identified taxon (Marston 2014). Results are presented by each sample and recovery technique (flotation and non-flotation) aggregated by provenience. Absolute counts and weights, however, do not control for unevenness in the data or biases relating to preservation and sampling error (Kandane 1988; Miller 1988; Pearsall 2015; Popper 1988; Scarry 1986; VanDerwarker 2003). As raw counts and weights are dependent upon the original sample size and percentage of the sample sorted, additional standardization is required for comparison with other samples or sites (Marston 2014; Popper 1988). The descriptive techniques provide the foundation for further quantitative analyses to identify patterning in the data set, such as changes in taxon frequency over time and differences among features (Pearsall 2015).

Ubiquity Measures

Ubiquity, a standardized measure widely used in plant macroremain analysis, measures the number of samples in which a taxon is identified rather than the number of specimens represented by the taxon. (Marston 2014; Pearsall 2015; Popper 1988). Ubiquity standardizes presence/absence values across all samples and ameliorates the problems associated with raw, unstandardized data by measuring the frequency of occurrence rather than abundance (Marston 2014; VanDerwarker 2003). Ubiquity conveys that a taxon is present and provides a measure of its commonality and spatial abundance (Pearsall 2015). Occurrence of a plant widely around a site implies that many households had access to the plant, that it was common enough to be frequently charred and preserved (Pearsall 2015). Ubiquity is also useful for considering diverse classes of data together, such as calculating plant and animal species over the same contexts (Pearsall 2015). Ubiquity works best when all samples are taken from similar types of contexts under similar depositional conditions and sampling measures, as is the case with the Finch assemblage (Hastorf 1999; Marston 2014). The Finch contexts also meet the minimum sample requirement for ubiquity analysis, established as ten samples (Hubbard 1976). Although ubiquity has many advantages, the metric remains susceptible to preservation issues and may obscure patterns where occurrence frequency remains constant but there are significant changes in quantities (Scarry 1986; VanDerwarker 2003).

The presence of a specific taxon is recorded for each sample and a percentage is computed for all of the samples in which the taxon is present (Popper 1988). For example, if hickory nutshell is present in three out of ten samples, then its ubiquity value is 0.30 or 30 percent. The formula is expressed as $U = x/t$ where U is ubiquity, x is the number of contexts a particular taxon is present, and t is the total number of contexts. Ubiquity values are calculated using the plant macroremains recovered using flotation and non-flotation techniques.

Ratios

The ratio represents a simple statistic that standardizes plant macroremains by relating the raw data to a constant variable (Miller 1988; Pearsall 2015; Scarry 1986). Ratios overcome some of the problems of absolute counts and can provide more insightful results than ubiquity measures. Ratios in plant macroremain analysis include two types: dependent and independent (or comparison) (Marston 2014; Miller 1988; Pearsall 2015; VanDerwarker 2003). In dependent ratios, the numerator is a subset of the denominator. Independent ratios use two mutually exclusive variables for the numerator and denominator (Miller 1988). A single ratio, however, is in itself meaningless and has interpretive value only through comparison with other ratios (Scarry 2003; VanDerwarker 2003). Ratios reveal only the relative importance of plants within varied deposits and not the absolute dietary contribution of actual resources used in the past (Scarry 1986).

Two ratios are used in the quantitative analysis of the plant macroremains from Finch: density and plant food. Both the density and plant food ratios were calculated for samples aggregated by provenience, such as a discrete cultural feature or excavation unit. Density ratios (*d*) are calculated using the plant macroremain data derived solely from flotation samples. The plant food (*q*) ratio uses plant macroremians recovered using flotation and non-flotation techniques.

The density ratio standardizes plant data in terms of soil volume by dividing the absolute count or weight of carbonized plant material with the total soil volume for each sample or context. By standardizing the counts and weights by soil volume it is possible to assess overall abundance of plant food taxa and wood, allowing for comparison across contexts (Marston 2014; Miller 1988). The density measure considers the plant remains relative to all of the other activities that may be represented in the deposit (Scarry 1986; VanDerwarker 2003). Density measures the abundance of plant taxa, based on the assumption that larger volumes of soil yield more plant remains. Differences in the contexts and the manner of deposition between samples structure the relationship between soil volume and the size of the plant assemblage. As such, density measures are useful in interpreting feature function (VanDerwarker 2003). In the Midwest, density numbers are typically measured as the abundance per ten liters floated. This ratio is expressed as $d = (a/s) *10$ where *d* is density, *a* is abundance count (*c*) or weight (*w*) of a particular taxon in a given context, and s is the total number of liters floated from that contexts.

The plant food ratio standardizes by plant food weight in order to assess the importance of a specific plant relative to other plants in a given sample or context (Scarry 1986; VanDerwarker 2003). Standardizing by plant weight considers the contribution of a specific plant taxon, or category of plants, solely in terms of plant related activities and may be a more sensitive indicator of spatial and temporal differences in plant use. The denominator of the plant food ratio is the sum of weights for all carbonized plant food specimens from all samples. The numerator is the count of the specific plant taxon, or category of plant taxons, of interest. The ratio is expressed as $q = a/f$ where q is the plant food ratio, a is abundance count (c) or weight (w) of a particular taxon in a given context, and f is the total plant food weight from all contexts.

As ratios are calculated for individual samples, and there are numerous samples for the Finch site, the ratio data is summarized using box plots, as described in Chapter 5 (Cleveland 1994; Marston 2014; McGill et al. 1978; Scarry 1986; Scarry and Steponaitis 1997; Wilkinson et al. 1992; VanDerwarker 2003). The plant data used in this analysis and summarized in the box plots are re-expressed as natural logarithms. Transforming the data in this way normalizes skewed distributions and thus facilitates the visual and statistical recognition of patterns in the data (Scarry and Seponaitis 1997; Cleveland 1994; Velleman and Hoaglin 1982; VanDerwarker et al. 2014).

Diversity

The diversity of plant, and animal taxa (see below), associated with the Early Woodland and Middle Woodland assemblages is assessed through the measuring of richness and equitability (evenness). Richness (S) refers to the actual number of taxa in a given assemblage or community with more taxa indicative of a richer assemblage (Kintigh 1984, 1989; Peres 2010; Reitz and Wing 2008). Equitability (V’) is the differing relative abundance, or the uniformity of distribution, of each species in the assemblage (Colinvaux 1986; Peres 2010). The Shannon-Weaver diversity index (H’) combines both richness and evenness into a single measure (Cole 1994; Reitz and Wing 2008). Using the Shannon-Weaver index, assemblages with an even distribution of abundance between taxa have a higher diversity that samples with the same number of taxa, but with less even distribution of these taxa (Peres 2010; Reitz and Wing 2008). Richness (S), equitability (V’), and the Shannon-Weaver index (H’) are calculated separately for the plant and animal taxa represented in the Early and Middle Woodland assemblages. The evenness (V’) values range from 0 to 1 with a value of 1 indicating an even distribution of taxa and lower values a less even distribution (Reitz and Wing 2008).

Faunal Remains

The Finch site faunal assemblage, largely composed of vertebrate faunal remains, was analyzed as part of a Master's Thesis project (Stencil 2015) and was summarized in the cultural resource management report (Haas 2019). Stencil (2015) performed the identifications, addressed seasonality, and recorded a wealth of data regarding bone modification.

This dissertation project conducts new quantitative analyses on the Finch site zooarchaeological data, implementing the refined site structure model (Haas 2017, 2019) associating the faunal data with the Early and Middle Woodland occupations at a more fine-grained level. The new analyses characterize the Early and Middle Woodland faunal assemblage compositions through bone weight, Number of Identified Specimens (NISP), and ubiquity. Together, these techniques gauge the relative importance of taxa (VanDerwarker and Peres 2010). NISP values examine the relative taxonomic abundances and frequencies of assemblages (Grayson 1984). Bone weight correlates to meat weight, therefore estimating the dietary contributions of identified taxa (Uerpmann 1973; Chaplin 1971; Hudson 1990). Ubiquity is effective in tracking changes in taxa use over time.

In a consideration of taphonomic processes, it is important to note that the Finch site faunal assemblage does not represent the full suite of animals that were used, discarded, and deposited by the past site occupants. A number of factors affect archaeological faunal assemblages including bone survivorship (based on structural density of bone), environmental conditions (climate, temperature, soil types), carnivore or rodent ravaging, and weathering (Binford and Bertram 1977; Hudson 1993; Lyman 1994, 1994; Stahl 1995;VanDerwarker 2003).

Field Recovery, Laboratory Processing, and Initial Identification

Faunal material was recovered from unit and feature contexts through flotation samples as well as by ¼ inch dry screen, ⅟₁₆ inch water screening, and piece plots. Identifications were completed using comparative collections from the University of Wisconsin-Milwaukee Zooarchaeology Laboratory, the University of Wisconsin-Madison Zoology Museum, as well as comparative texts by Becker (1983), Gilbert (1990), and Gilbert et. al. (1996). Specimens from all recovery techniques were identified to the most specific taxonomic level possible. Specimens that could not be identified to species-level were, if possible, identified to taxonomic class: mammal, bird, fish, reptile, amphibian, and bivalve, using several diagnostic indicators (Beisaw 2013; Davis 1987; Lyman 1994; Reitz and Wing 2008; Wheeler and Jones 1989). Any specimen that could not be identified to taxonomic class, due to fragmentation or a lack of diagnostic characteristics, was labeled "unidentified." Both identified and unidentified specimens were inventoried for modification, including burning, cut marks, gnaw marks, and evidence of working for ornamental or tool use (Stencil 2015).

When possible, mammal-class specimens were differentiated by size-class into three: large, medium, and small. Large-mammal taxa consist of species equal to or greater in size (average adult weight) than white-tailed deer (*Odocoileus virginianus*). Small-mammal taxa consist of species equal to or less in size (average adult weight) than the eastern cottontail rabbit (*Sylvilagus floridanus*). Medium mammals consist of all taxa that fall in between these large and small taxa distinctions. During analysis, mammal specimens that could not be differentiated into the small, medium, or large size groups but were assuredly not part of the small-mammal size group (based on cortical thickness and general specimen dimensions) were assigned a medium/large distinction. Assigning a medium/large mammal group distinction contributed a more refined interpretation of the analysis than simply leaving those particular fragments without a size distinction.

Bone weight, combined with NISP (number of identified specimens) quantifications, are among the most standardized primary data collected in faunal analysis. All vertebrate specimens were tallied using NISP quantification. NISP values are used extensively to examine the relative taxonomic abundances and frequencies of assemblages (Grayson 1984). Bone weight was recorded to the nearest 0.01 gram. Bone weight has been demonstrated to have a distinct correlation to meat weight and thus can provide quantitative measurements to estimate the dietary contributions between identified taxa (Uerpmann 1973; Chaplin 1971; Hudson 1990). Bone weight avoids fragmentation bias and has been implemented as a comparative measure in a number of studies, complemented by NISP, and used to gauge the relative importance of taxa within a faunal assemblage (Peres 2010).

Specimens were assessed for their indication of season of occupation. Season of occupation data was inferred from the presence of fish species documented as being more accessible and exploitable dependent upon seasonal spawning (Yerkes 1981, Yerkes 1981; Becker 1983; Wheeler and Jones 1989). Additionally, the seasonal availability and ease of exploitation for migratory bird species was examined and correlated to the presence of identified species in the Finch site faunal assemblage (O'Connor 2000; Temple et. al. 1997; Speth 1987).

Bone Modification

For this dissertation project, three aspects of bone modification are of particular importance as they relate directly to food processing behavior. These aspects include butchery evidence, fragmentation ratios, and burned bone patterning. The methods employed by Stencil (2015) relative to these three types of bone modification are briefly summarized below.

Evidence of butchery patterns is derived from the presence of cut marks. Cut marks created by stone tools have distinct morphological traits distinguishable from marks left by carnivore and rodent gnawing and gouging. Butchering cut marks made by stone tools leave elongated, V-shaped to U-shaped cross-sectioned fine striations that are often grouped in multiple parallel cuts (Lyman 1994). Cut marks appear on bone as an inadvertent effect, or combination of effects, from butchery events such as skinning, removing meat before or after cooking, or segmenting a larger body for transport and/or dispersal (Reitz and Wing 2008). Cut marks were identified with the aid of a 10X power hand lens.

Fragmentation of bone in an archaeological assemblage results from non-cultural forces such as weathering, trampling, and/or carnivore and rodent gnawing (Reitz and Wing 2008). Fragmentation is also attributable to cultural practices of butchery and food preparation techniques such as boiling, baking, roasting, marrow extraction, and the production of bone grease (Binford 1978; Gifford-Gonzalez 1989; Leechman 1951; Outram 2001; Prince 2007; Reitz and Wing 2008; Stoessel 2014; Vehik 1977). Highly fragmented bone in the archaeological record is recognized as discard from bone grease processing (Church and Lyman 2003). Bone grease rendering is most effective with small bone fragments (Church and Lyman 2003). It is noted, however, that the ultimate form of bone debris at residential or short term campsites is determined by cooking technology (Gifford-Gonzalez 1993). For example, use of smaller vessels may result in a higher degree of fragmentation than would be necessary if larger vessels were used in the cooking process.

Fragmentation metrics of the Finch site faunal assemblage are used to assess processing techniques of bone marrow extraction and bone grease production (Stencil 2015). Based on the premise that bone grease rendering is most effective with smaller bone fragments, highly fragmented archaeological bone assemblages are associated with the cultural practices of marrow and bone grease exploitation (Gifford-Gonzalez 1989; Outram 2001; Prince 2007; Stoessel 2014; Vehik 1977). Following the methods established by Stencil (2015), and adapted from Grimm (2010), Outram (2001) and Prince (2007), a fragmentation value (*g*) is measured by the ratio of *bone weight : NISP*. The higher the ratio the less amount of fragmentation and the lower the ratio the higher amount of bone fragments (Stencil 2015). The fragmentation ratio is correlated to a processing behavior continuum that ranges from no marrow or bone grease production, to marrow extraction only, to both marrow extraction and bone grease rendering (Outtram 2001; Stencil 2015). In many cases, marrow extraction occurs prior to bone grease processing; in these instances, indicators of marrow extraction would be obscured by the later activity of bone grease rendering (Binford 1978; Prince 2007).

Burned bone accounts for the majority of bone recovered from the Finch site and directly corresponds to cooking and processing activities (Clark and Ligouis 2010; Stencil 2015; Stiner et al. 1995). The zooarchaeological analysis completed by Stencil (2015) for the Finch assemblage recorded the presence/absence of burning on each specimen, classified burned specimens as exhibiting a single or multiple color, and used an ordinal scale to record the color (or colors present) on each bone fragment. All three aspects are related to cooking and processing techniques and are used as part of the dissertation project to develop a model of animal processing tasks.

Bone burned to a single color versus multiple colors is used to differentiated between two discrete types of processing tasks (Stencil 2015). Bone fragments burned to a single color on all surfaces were likely burned as fragments, rather than resulting from fracturing in a fire, and represent discarded/refuse fragments (Cain 2005; Stiner et al. 1995; Stencil 2015:99). Single color burned bone identifies activity areas where bone was fragmented and stripped of all meat, marrow and tissue as a result of food processing for marrow removal or grease production (Stencil 2015:99, 123). Bone burned to multiple colors is associated with bone that burned as fleshed bone. Mixed colors of burning have been demonstrated experimentally to be the result of multiple exposure temperatures. These may be a product of roasting, the multiple colors a result of bone surfaces being partially protected by soft tissue or remaining flesh, or bones freshly discarded into the fire after processing (Asmussen 2009; Buikstra and Swegle 1989; Stencil 2015:122).

The use of color identification of burned bone as a marker for burning intensity has been verified by thorough experimentation and review (Shipman et al. 1984; Buikstra and Swegle 1989; Stiner et al. 1995; Bennett 1999; Cain 2005; Asmussen 2009). Increased heat affects the surface color of bone in a progression from brown, to black, to grey, to blue, to white (Asmussen 2009: 529). Stencil (2015) recorded color using an ordinal scale of 0 to 4 per the Munsell Soil Color Chart and a 10x power hand lens to ensure consistent color categorization and dispel any surface- altering taphonomic factors (Cain 2005). The first color ordinal, “0”, signifies no color change, unburned bone; “1” signifies a 5YR2/1 black; “2” signifies a 5YR 6/1 gray; “3” signifies a 5BG5/10 blue; “4” signifies a 10Y9/0 white.

Inferring Food Processing Activities

Food processing is assessed through three aspects of the plant macroremains and faunal assemblage evaluating: (1) intensity and frequency of activities involving fire; (2) butchery practices; and (3) evidence for roasting, bone marrow extraction, and bone grease rendering. Intensity and frequency of activities involving fire is interpreted from a quantitative comparison of wood charcoal and burned animal bone. Butchery practices are inferred from cut marks, representative of skinning, removing meat before or after cooking, or segmenting a larger body for transport and/or dispersal (Reitz and Wing 2008). Finally, evidence for specific animal processing activities, delineating roasting, bone marrow extraction, and bone grease rendering tasks, is assessed using a model developed for the dissertation project; this model is based on fragmentation ratios and burned bone color patterning, adapted from Stencil (2015) (Table 6.1). Fragmentation ratios (*bone weight: NISP*) evaluate processing techniques of bone marrow extraction and bone grease production (Reitz and Wing 2008; Binford 1978; Leechman 1951).

Table 6.1. Modeling Animal Processing Tasks from the Zooarchaeological Assemblage

Activity	Assemblage Description	Fragmentation Value	Burned Bone Color Pattern
No bone marrow or bone grease processing	Bone assemblage largely intact with minimal human modification	Low fragmentation & high fragmentation ratio	High frequency of multiple colored burned bone
Marrow extraction only	Evidence of deliberate long bone shaft fractures. Articulations deposited whole with majority of axial elements.	Moderate fragmentation & moderate fragmentation ratio	High frequencies of single colored burned bone
Marrow extraction and bone grease production	Cancellous and diaphysis bone fractured. Diaphysis bone in splinters and cancellous bone fragmented to various degees dependent upon intensity.	High fragmentation & low fragmentation ratio	High frequencies of single colored burned bone

Note: Adapted from Clark and Ligouis 2012; Outram 2001; Prince 20017; Stencil 2015; and Stiner et al. 1995

The archaeological model for food processing relies heavily on the zooarchaeological data. Food processing activities can be inferred from plant macroremain assemblages, but typically use ratios involving nutmeats/nutshell and maize kernels/cupules (VanDerwarker 2013; Scarry and Steponaitis 1997; Scarry 1986). However, at Finch, no maize has been identified within the Early and Middle Woodland assemblages and nutmeats are rare, thus precluding the implementation of these techniques for inferring specific food processing activities for these types of resources.

Ecological Context, Habitat, and Use

In order to understand the types of plants and animals available to the prehistoric occupants of the Finch site, it is important to delineate and discuss the unique environments and ecosystem communities in and surrounding the Finch site. An environmental reconstruction for the Finch site, using documentary sources (Brink 1835, Curtis 1959, Martin 1965, Finley 1976, Goldstein and Kind 1987) and a ten kilometer catchment analysis, has been completed by Stencil (2015) (Figure 6.1; Figure 6.2). Broadly, the Finch site is located within a large area of oak openings (or savanna) surrounded by modest zones of open water and marshlands and small locales of oak forest and prairie. Stencil (2015:27) identifies six vegetational zones in the ten kilometer catchment area surrounding the Finch site including, in order of percent land coverage: oak savannas (69.3 percent), open water or aquatic marsh (13.7 percent) and wetlands (13.1 percent), oak forests (2.1 percent), deciduous forests (1.3 percent), and prairies (0.5 percent) (Curtis 1959; Finley 1976; Goldstein and Kind 1987; Stencil 2015).

The Finch site itself, as well as much of the catchment area surrounding the site, is within an oak opening/savanna landscape. In Wisconsin, oak openings/savanna constitute one of the most widespread communities in pre-settlement times, occurring throughout the prairie-forest floristic province south and west of the tension zone (Curtis 1959:326). Oak savannah rely heavily upon the regenerative properties of fire and quickly close off and change into a oak forest habitat without large scale burning (Curtis 1959:335). Common tree species include bur oak (*Quercus macrocarpa*), black oak (*Querucs veluntina*) and white oak (*Quercus alba*). Other trees that are

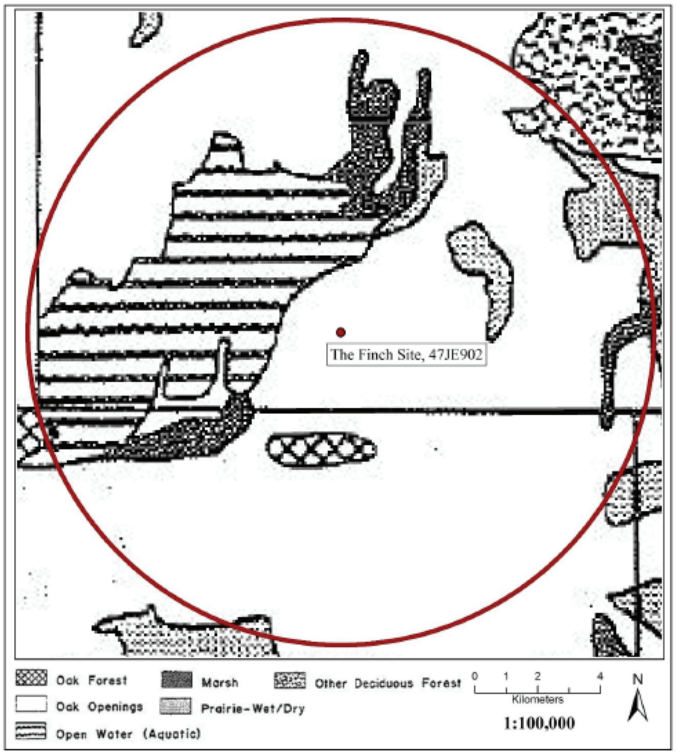


Figure 6.1. Ten kilometer catchment area of the Finch site based on Stencil (2015) and Goldstein and Kind 1987).

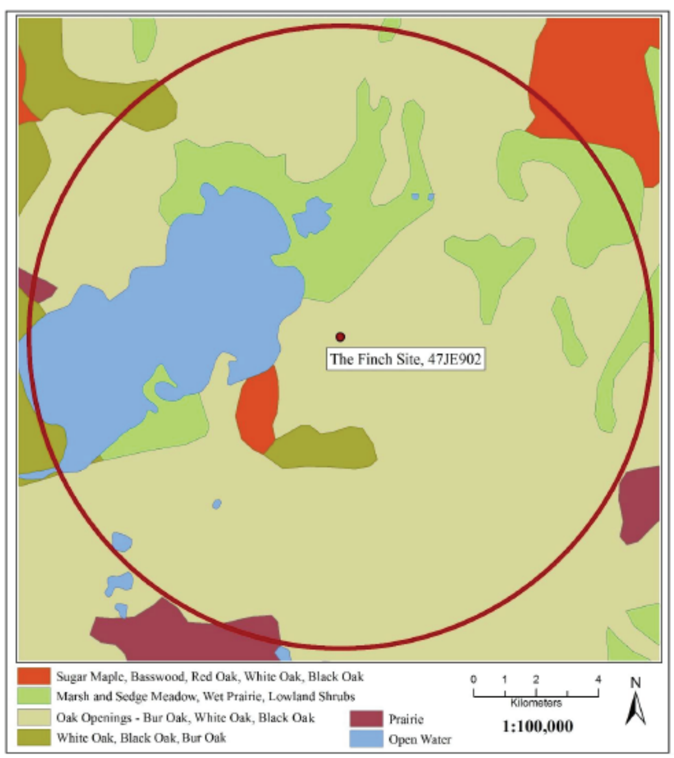


Figure 6.2. Ten kilometer catchment area of the Finch site based on Stencil (2015) and Finley 1976.

present, but much less common, include shagbark hickory (*Carya ovata*), large-toothed aspen (*Populus grandidentata*), and black cherry (*Prunus serotina*) (Curtis 1959). Shagbark hickory (*Carya ovata*) reaches its maximum presence in oak opening ecological zone within Wisconsin (Curtis 1959). Species of the aster/daisy (Asteraceae), grass (Poaceae), and Fabaceae (bean) families are prevalent. Common species in the oak openings are hog peanut (*Amphicarpa bracteata*), flowering spurge (*Euphorbia corollata*), lead plant (*Amorpha canescens*), bedstraw (*Galium boreale*), wild bergmot (*Monarda fistulosa*), rose (Rosa sp.), gray dogwood (*Cornus racemosa*), hazelnut (*Corylus americana*), spreading dogbane (*Apocynum androsaemifolium*), and big bluestem (*Andropogon gerardi*). Expected fauna in oak openings include a wide variety of mammals along with birds, reptiles, and amphibians (Stencil 2015: 210-211).

Ecological and Ethnohistorical Context for the Plant Macroremain Assemblage

A variety of plant taxa were identified in the Early and Middle Woodland plant macroremain assemblages at Finch, including wood charcoal, nutshell, squash rind, and several wild seed varieties (Table 6.2). Domesticates were identified in the plant macroremain assemblages, consisting of squash (*Cucurbita* sp.) rind, present in both Early and Middle Woodland assemblage, and tobacco (*Nicotiania* sp.), associated with the Middle Woodland occupation. Both Early and Middle Woodland assemblages are broadly similar in that they share a common set of tree crops, including various species of the walnut family (Juglandaceae) and acorn, as well as squash rind. There is little commonality between the seed resources of the Early Woodland and Middle Woodland assemblages which may be attributable, in part, to the overall low numbers of seeds recovered from the site.

The following discussion focuses on the nut resources and squash as these represent the most abundant plant taxa recovered common to both the Early Woodland and Middle Woodland plant macroremain assemblages. Information about habitat, seasonality, nutrition, processing techniques, and food and non-food uses are discussed.

Nuts

Throughout prehistory, nuts are considered some of the most important wild plant foods for Native American peoples of the Eastern Woodlands (Scarry 2003). Nutmeats have one of the highest caloric values (Talalay et al. 1984). In the Eastern Woodlands, three woody plant families, Junglandaceae (walnut family), Beulaceae (birch family), and Fagaceae (beech family), produce edible nuts. All of the available nuts ripen in the fall and have woody shells that require removal prior to nutmeat consumption. Nuts of the walnut, birch, and beech families differ relative to nutritional composition, collection, processing, and storage techniques, as well as culinary uses (Scarry 2003).

Table 6.2. Common and Taxonomic Names of Plants Identified in the Early Woodland and Middle Woodland Plant Macroremain Assemblages from Finch.

Taxon	Common Name	Early Woodland (Presence)	Middle Woodland (Presence)
Wood Charcoal		x	x
Nuts			
Carya sp.	hickory		x
Carya cordiformis	bitternut hickory		x
Corylus sp.	hazelnut		x
Juglandaceae	walnut family	x	x
Juglans nigra	black walnut	x	
Quercus sp.	acorn	x	x
Unidentified nutshell		x	x
Nutmeat			x
Seeds			
Grain/Oil Seeds & Greens Seeds			
Polygonum sp.	knotweed		x
Fruit Seeds			
Solanaceae	nightshade (family)	x	
Other Seeds			
Euphorbia sp.	spurge		x
Galium sp.	bedstraw		x
Nicotiana sp.	tobacoo		x
Unidentifiable		x	x
Squash/Cucurbits			
Cucurbita sp. rind	squash rind	x	x

Hickory (*Carya* sp.)

Hickory trees are found in oak openings/savannas favoring mixed hardwood forests and upland slopes, typically occurring in groves (Talalay et al. 1984). Nut production is cyclical, trees within a grove tend to be on the same cycle, with heavy crop yields every two to three years (Scarry 2003). In good years, masts may be exceptionally locally abundant allowing for the harvest of large quantities of nuts with relatively little time spent on search and travel (Scarry 2003). Hickory nuts are generally ripe from September to November (Talalay et al. 1984). When nuts ripen and drop in the fall, their thick shells protect them from insects and mold, but are the favored food of many animals, especially squirrels (Scarry 2003).

Hickory nuts have a high fat content with moderate quantities of protein but are a poor source of carbohydrates (Scarry 2003). Thick-shelled hickories require processing in order to separate the nutmeat from shell. Ethnographic sources indicate that oil and milk were the typical desired products from hickory nuts (Swanton 1946; Talalay et al. 1984). Pulverizing the hickory nuts and placing them in slowly boiling water results in the nutmeat oil rising to the surface where it can be skimmed off (Talalay et al. 1984). What remains of the nutmeats, mostly protein, dissolves into a milky emulsion in the water, and by pouring the fluid through a strainer all of the shells are removed. Experimental activities indicate that the process works best if the nuts are first dried and the oil separates more readily when the nuts are finely ground (Fritz et al. 2001; Scarry 2003; Talalay et al. 1984). Based on ethnohistoric data, the oil was used as a beverage, a stock for soup, and/or as a cooking ingredient (Speck 1909; Swanton 1946; Talalay et al. 1984).

Other experimental studies show that if the desired product is nutmeats, the pulverized mass of hickory nuts are dropped into water at a rolling boil and stirred. By doing this, almost all of the shell fragments sink to the bottom and nearly all of the nutmeats float, or are suspended, and are skimmed off with a strainer. The resulting nutmeat powder is available for immediate use in its wet state for cooking purposes or can be spread to dry for storage (Talalay et al. 1984).

Acorn (*Quercus* sp.)

Several varieties of oak are common to oak openings/savannas including bur oak (*Quercus macrocarpa*), black oak (*Quercus veluntina*), and white oak (*Quercus alba*). These oaks fall into two broad subgenera consisting of the white oaks (Q Lepidobalanus) and the red/black oaks (Q Erythrobalanus). Bur oak is part of the white oak subgenera. White oak acorns mature in one year, are sweet, and can be eaten with minimal processing. Red-oak acorns take two years to mature, are bitter, and contain high levels of tannic acid that must be leached before they can be eaten (Scarry 2003). Depending on the species, oaks produce a good crop of acorns every two to three years.

Acorns are a good source of carbohydrates and have a lower protein and fat content as compared to walnuts, hickories, or hazelnuts (Scarry 2003). Acorns are generally available from September to November but timing is important for the harvesting and storage of substantial quantities of acorns. Acorns, given adequate moisture, sprout soon after dropping and have an increased susceptibility to insect and mold infestation given their thin shells Moreover, nuts of the white-oak group are a favorite food of squirrels, deer, turkeys, and other wildlife (Petruso and Wickens 1984; Scarry 2003).

Acorns must be parched before they can be stored in order to prevent sprouting, kill worm infestations, and reduce mold problems (Petruso and Wickens 1984; Scarry 2003). Most acorns require leaching to be palatable, although white oak and bur oak acorns are described as not needing leeching in some accounts (Densmore 1979; Hilger 1992; Smith 1932). Ethnohistoric narratives indicate several techniques for leaching the tannin from acorns (Petrusco and Wickens 1984; Scarry 2003). Rinsing in water and boiling in lye (or ash) are two commonly cited techniques (Smith 1923, 1932). In some cases, the nuts are initially parched or roasted prior to boiling or soaked in fresh water within pits, baskets, or sandy depressions (Densmore 1979; Hilger 1992; Scarry 2003; Smith 1923, 1932)

Acorns, as a naturally occurring and storable carbohydrate source, were typically used as sources of starch (Dunham 2009). Once the tannin is removed, kernels are pounded into a paste that can be used to thicken broths or ground into a meal. The acorn meal could be baked to make bread or combined with water to make gruel (Scarry 2003; Swanton 1946). Although acorns are low in fat, oil is sometimes extracted from them by pressing and boiling the kernels (Scarry 2003; Swanton 1946). Acorns were a widely used food source in the Eastern Woodlands and were very important prior to the adoption of maize (Asch et al. 1972; Egan 1988; Gardner 1997; Yarnell 1964). Acorns compare favorably with wild rice and maize relative to general nutritional characteristics (Dunham 2009).

Hazelnut (*Corylus* sp.)

Hazel shrubs occur as thickets in open areas or forest margins in dry to moist environments, both on hillsides and along streams, and as a prevalent ground layer species of oak openings (Curtis 1959; Scarry 2003; Talalay et al. 1984). The shrubs tend to colonize old fields, village sites, and other anthropogenic habitats. Hazels produce nuts in their first year and typically yield a good crop every two to three years (Nesom 2007). Hazelnuts begin to ripen in the late summer at which time they are enclosed in papery bracts and remain on the shrub. In October and November, the bracts dry and open, releasing the nuts to the ground where they are rapidly collected by animals (Scarry 2003). The best strategy for human collection of hazelnuts is to pick or beat the nuts from the shrubs after the leaves have fallen but before the bracts have split (Scarry 2003; Talalay et al. 1984).

Hazelnuts have a high fat content, moderate levels of protein, and relatively low levels of carbohydrates (Scarry 2003). The nuts were likely hand picked from the shell rather than for oil processing (Scarry 2003). The nutshells are relatively thin and easily cracked and the large kernel, loose within the shell, falls out when the nut is opened. Crushing and boiling experiments have been demonstrated as an inefficient means of nutmeat extraction as the nutmeats become waterlogged and sink with the shell (Talalay et al. 1984).

Black Walnut (*Juglans nigra*)

Walnuts grow best in well drained neutral soils, are commonly found on hillsides and rich mesic bottomlands, and are found within oak openings/savannas (Curtis 1959; Talalay et al. 1984). Walnuts tend not to occur in groves and produce good crops every two to three years. Walnuts are generally ripe from September through November, though nuts may still be available through December (Talalay et al. 1984:347). The lengthy period of walnut availability, as compared to other nuts, is attributable to the bitter tasting hull, size, and hardness, factors that discourage wildlife consumption of the nuts (Talalay et al. 1984). Black walnut processing may be most productive after they have rotten, typically in late fall/early December; through experiment, Talalay et al. (1984:350) found the most efficient method for black walnuts, carried out at the collection site, involved rolling the rotted nut in its hull underfoot and then picking away the split and shredded hull by hand.

Walnuts have a high protein and fat content, are low in carbohydrates, and a sweet palatability (Scarry 2003). Walnuts have hard shells that are difficult to crack, but once split, the large nutmeats are readily separated from the shell. Processing walnuts following the techniques used to extract hickory oil results in an unpalatable, tannin-laden oil (Talalay et al. 1984). Walnuts can be stored and kept for extended periods of time (Scarry 2003). Walnut nutshell can be used for fuel and, along with the bark, leaves, and husks, for medicinal purposes (Fritz 2017). The fruit and nut stain deeply and have been historically used as dyes, as have the bark and leaves (Talalay et al. 1984).

Cucurbit (Squash/Gourd/Pumpkin and Bottle Gourd)

Wild species of *Cucurbita* are native to North and South America and native pepo gourds were the first plants cultivated in eastern North America (Fritz 1999). *Cucurbita* sp. grows as a large annual vine preferring well drained loams in full sun. The plants will vigorously establish themselves in disturbed areas, such as garden plots and trash heaps (King 1985). The fruit generally ripens between May to September.

Rind, flesh, and seeds of *Cucurbit*a species are edible and nutritionally rich (King 1985). The fruit can be eaten green, as a vegetable, or boiled or roasted when mature (King 1985). Ethnohistoric data indicates that *Cucurbita* was commonly cut into strips and dried; *Cucurbita* seeds contain high amounts of oil (King 1985; Perkl 1998). The dried pepo of *Lagenaria siceraria* was, and is, used, as a container by people in many areas of the world, including prehistoric North America. *Cucurbita* sp. containers have been recovered from prehistoric sites in the eastern United States (Fritz 2017; Watson 1976). Ethnohistorically, the Ojibwe consumed pumpkins and squash fresh and also dried the plant for use later in the winter (Densmore 1979, 2005; Hilger 1959). When consumed fresh, squash was baked in coals (Hilger 1959); dried squash and pumpkin were boiled with meat or maple sugar (Densmore 2005; Hilger 1959).

Ethnohistorical and archaeological data indicate that at least two Cucurbita species, *Cucurbita pepo* L. and *Cucurbita argyrosperma*, occurred prehistorically in the Eastern Woodlands (Asch and Asch 1985; Fritz 1994; 2012). Genetic analyses have further determined that at least one lineage of *Cucurbita pepo* was independently domesticated in the Eastern Woodlands (Decker-Walters et al. 1993; Fritz 2017). Association with humans, including domestication and "co-evolution" have altered the characteristics of *Cucurbita*. Wild *Cucurbita* are small with bitter flesh, containing protein-rich seeds. Eventually, larger, non-bitter, thick-fleshed fruits were developed, with seed size increasing through time (King 1985; Perkl 1998). The transition from wild harvesting to cultivation and initial domestication of squash is marked in the eastern United States by an 11 mm seed length boundary (Cowan 1997; King 1985).

Evidence for non-domesticated cucurbit occurs as early as 7000 BP (Asch and Asch 1985; Smith 1992). Domesticated cucurbit is found at numerous sites after 3000 BP and may be present as early as 4500 BP (Fritz 1990; King 1995). The antiquity of squash use in the northern and western Great Lakes region is not well known (Kooiman 2018).

As species identification of archaeological rind is difficult due to inter-specific overlap in thickness (King 1985; Roberts 2019), the seed length criteria is typically relied upon for a determination of cultivated species in those regions within the habitat area of wild squash. However, as the native habitat of wild squash occurs well to the south of Wisconsin (U.S. National Plant Germplasm System 2019), the squash rind fragments from the Finch site are classified as domesticates.

Ecological Context for the Zooarchaeological Remains

A variety of animals are represented in the Early Woodland and Middle Woodland assemblages from Finch including birds, fish, mammals and reptiles (Table 6.3). Taxons present in the assemblage indicate use of oak openings, the ecological zone containing the Finch site, as well as the surrounding ecological zones consisting of prairies, oak/deciduous forests and aquatic/wetlands. Mammal species, especially medium and large mammals, are well represented in both the Early and Middle Woodland zooarchaeological assemblages. Mammal species include

Table 6.3. Common and Taxonomic Names of Animals and Habitats Identified in the Early Woodland and Middle Woodland Zooarchaeological Assemblages from Finch.

Taxon	Common Name	Early Woodland	Middle Woodland	Oak Openings	Prairies	Oak/ Deciduous	Aquatic/ Wetlands
Bird							
	Unidentified	x	x				
Fish							
Ictalurus punctatus	channel catfish		x				x
Unidentified		x	x				
Mammal							
Artiodactyl	even-toed ungulate	x	x				
Canis sp.	wolf/coyote/dog	x		x	x	x	
Cervus canadensis	elk	x		x	x	x	
Mephitis mephitis	striped skunk		x	x		x	x
Odocoileus virginianus	white-tailed deer	x	x	x		x	x
Ondatra zibethicus	muskrat		x				x
Procyon lotor	raccoon		x	x		x	x
Unidentified		x	x				
Reptile							
Testudines	turtle	x	x	x	x	x	x
Unidentified		x	x				

white-tailed deer, elk, and even-toed ungulate (likely more white-tailed deer) demonstrating the use of oak openings and oak forests ecological zones for large mammal procurement (Stencil 2015:109). Other mammals common to oak openings and oak/deciduous forests and present in the zooarchaeological assemblages include wolf/coyote/dog, striped skunk, and raccoon. Striped skunk and raccoon are also found in wetland ecological zones. Turtles are present in the assemblage, although are not identifiable to species. Turtles are found in oak openings, prairies, oak/deciduous forests, and aquatic/wetland ecological zones.

Description of the Samples and Seasonality

The plant macroremains and zooarchaeological assemblage associated with the Early and Middle Woodland components are derived from feature and unit contexts. A description of the recovery techniques and proveniences from which the plant macroremains and zooarchaeological remains are derived, the comparability of the Early and Middle Woodland zooarchaeological assemblages relative to number of identified specimens, as well as the seasonality of site occupation, is reviewed to address any potential issues relating to equifinality of the assemblages that may affect the data analysis and resulting interpretations. The plant macroremain and zooarchaeological assemblages are derived from the excavations at the Finch site that occurred in 2009, 2010, and 2012 (Haas 2019). Recovery techniques included flotation sampling, ¼-inch dry screening, ⅛-inch waterscreening, and piece plots. The proveniences and recovery techniques relative to the plant macroremain and zooarchaeological assemblages for the Early Woodland and Middle Woodland components at the Finch site are described below.

Plant Macroremains

The plant macroremain assemblage is derived from cultural features that are associated with the Early Woodland and Middle Woodland components. Recovery techniques for the plant macroremains included flotation sampling as well as recovery from ¼ -inch dry screening and ⅛-inch water screening techniques. As very few flotation samples were obtained from unit contexts, plant macreoremains, collected via flotation and/or screening from unit proveniences, are not included in the analysis.

The Early Woodland component contexts include 19 cultural features that have been identified as cooking pits, storage pits, artifact concentrations, post molds, a structure, and pits of an indeterminate function (Table 6.4; Table 6.5). Plant macroremains, recovered from both flotation samples and non-flotation recovery contexts, from 18 of the features are used in the following analysis. In all, flotation samples, totaling 350 liters of soil matrix, were obtained from 12 of the 18 features. Flotation samples were not collected from six features and, for one feature (Feature 110), a flotation sample was collected but matrix volume was not recorded.

Two Early Woodland features, features 81 and 681 yielded *Zea mays* cupule/cobb fragments and kernels. The presence of *Zea mays* in these Early Woodland features is attributable to contamination from the Late Woodland occupation and are not considered part of the Early Woodland plant macroremain assemblage. Based on an analysis of the feature content, the plant macroremains, excluding the corn, from feature 81 is included in the Early Woodland assemblage plant macroremain analysis. This feature yielded only one *Zea mays* fragment. feature 681, however, is more problematic and contamination likely more severe than for features 81. A total of seven *Zea mays* kernels were recovered from Feature 681, along with portions of Middle Woodland and Late Woodland vessels. Given the higher amounts of corn, coupled with diagnostics from later periods, Feature 681 is excluded from the plant macroremain and zooarchaeological analyses.

The Middle Woodland component contexts include 21 cultural features that have been identified as cooking pits, artifact concentrations, a structure, and pits of an indeterminate function (Table 6.5, Table 6.6). Plant macroremains, recovered from both flotation samples and non-flotation recovery contexts, from these 21 features are used in the following analysis. Flotation samples, totaling 198 liters of soil matrix, were obtained from each of the 21 cultural features. However, volumes were not recorded for two features (features 112 and 113).

As with the Early Woodland features, three Middle Woodland features (features 41, 88, and 146) yielded ten *Zea mays* kernels and one cupule fragment. The presence of *Zea mays* in these Middle Woodland features is attributable to contamination from the Late Woodland occupation and are not considered part of the Middle Woodland plant macroremain assemblage. The features are, however, attributable to the Middle Woodland components based on the presence of diagnostic material culture and/or their provenience within an area of intensive Middle Woodland activities.

Table 6.4. Early Woodland Features at Finch and Flotation Sample Collection

Feature	Flotation Sample	Liters	Site Region	Feature Type	Feature Function
12	Yes	3	D	Post Mold	Post Mold
17	No	--	D	Pit	Cooking
22	No	--	D	Pit	Unknown
25	Yes	180	D	Structure	Structure
34	Yes	26	D	Pit	Unknown
63	No	--	D	Artifact Scatter	Pottery
65	Yes	5	D	Pit	Cooking
66	Yes	7	D	Pit	Unknown
67	No	--	D	Pit	Unknown
68	Yes	5	D	Pit	Cooking
81	Yes	92	D	Pit	Cooking
83	Yes	10	D	Pit	Cooking
84	No	--	D	Pit	Cooking
93	Yes	6	D	Pit	Cooking
94	Yes	9	D	Pit	Unknown
110	Yes	--	D	Pit	Cooking
117	Yes	7	D	Pit	Unknown
581	No	-	D	Pit	Cooking
681	Yes	6	D	Pit	Cooking

Note: Feature 681 is not included in the analysis due to possible contamination from later occupations.

Zooarchaeological Assemblage

The Early and Middle Woodland zooarchaeological assemblages are derived from the cultural features associated with each component as described above and summarized in Table 6.4 and Table 6.6. In addition, faunal remains recovered from unit contexts are included in the analysis (Table 6.7). The unit context fauna was typically recovered through screening (¼-inch dry and ⅛-inch water). For the Early Woodland proveniences, 40 units are included in the analysis. A total of 57 units are associated with the Middle Woodland component.

The Early and Middle Woodland zooarchaeological assemblages exhibit similar patterning relative to the number of identifiable specimens (Figure 6.3). Both assemblages exhibit high frequencies of unidentifiable remains relative to NISP. The Early Woodland assemblage has a lower frequency of NISP, fully 17.80 percent, than the Middle Woodland assemblage (27.04 percent). The unidentifiable specimens account for 82.20 percent of the Early Woodland assemblage and 72.96 percent of the Middle Woodland assemblage. The high relative frequencies of unidentifiable remains likely relates to recovery technique, as waterscreen and flotation derived bone tends to be of a small size that precludes identification.

Table 6.5. Early Woodland and Middle Woodland Feature Types

Feature Type	Early Woodland	Middle Woodland
Cooking	9	9
Structure	1	1
Artifact Scatter	1	2
Pit (Indeterminate Function)	7	9
Post Mold	1	0
Total	19	21

Table 6.6. Middle Woodland Features at Finch and Flotation Sample Collection

Feature	Flotation Sample Collected	Liters	Site Region	Feature Type	Feature Function
37	Yes	16	C	Pit	Unknown
41	Yes	8	C	Pit	Unknown
47	Yes	5	C	Pit	Hearth/Cooking
48	Yes	32	C	Pit	Hearth/Cooking
82	Yes	8	D	Pit	Hearth/Cooking
88	Yes	6	C	Pit	Unknown
95	Yes	7	D	Pit	Hearth/Cooking
96	Yes	43	C	Structure	Structure
97	Yes	4	C	Pit	Unknown
100	Yes	8	D	Pit	Hearth/Cooking
103	Yes	8	D	Pit	Unknown
112	Yes*	--	A	Artifact Scatter	Pottery
113	Yes*	--	C	Artifact Scatter	Pottery
114	Yes	8	D	Pit	Hearth/Cooking
120	Yes	7	D	Pit	Unknown
121	Yes	8	C	Pit	Unknown
129	Yes	6	D	Pit	Hearth/Cooking
146	Yes	4	B	Pit	Cleaned out pit
167	Yes	8	D	Pit	Hearth/Cooking
168	Yes	9	D	Pit	Hearth/Cooking
2001	Yes	3	D	Pit	Unknown
	Total Liters	198			

*Flotation samples were collected for these features but liters were not recorded.

Table 6.7. Proveniences of the Early Woodland and Middle Woodland Zooarchaeological Assemblages

Component	Features	Units	Unit Total Area (m^2)	Units Total Volume (m^3)
Early Woodland	18	40	127.5	65.15
Middle Woodland	21	57	181.25	84.68

Based on bone weight, a different pattern is present for the Early and Middle Woodland zooarchaeological assemblages (Figure 6.4). For the Early Woodland assemblage, bone weight of identified specimens represents 52.34 percent and unidentified specimens total 47.66 percent of the assemblage. There is a nearly even split between the identified and unidentified specimens based on bone weight for the Early Woodland assemblage. The Middle Woodland assemblage, based on bone weight, is mostly composed of identifiable specimens, representing 73.62 percent of the assemblage. Unidentifiable specimens, for the Middle Woodland assemblage and based on bone weight, total 26.38 percent of the assemblage.

Seasonality

Seasonality is examined to assess comparability and the equifinality of the Early and Middle Woodland plant and animal assemblages (Table 6.9). Very few plant species are seasonal indicators for the Early Woodland component and there are no identifiable animals that provide seasonal data. Based on the plant resources, the Early Woodland occupation ranges from May through November. Given the low density of squash and the relative abundance of nutshell, the Early Woodland occupation of the site likely occurred, or was more intensive, in the fall months. Based on the chemical residue analysis (see Chapter 5), the Early Woodland occupation may have extended over winter, based on a the lipid signature indicative of fat-depleted herbivore from an IOCM vessel (vessel 3018).

A total of eight plant taxa and one animal species are seasonal indicators for the Middle Woodland occupation. The plant and animal taxa have seasonality indicators that range from April though November. As with the Early Woodland occupation, the relative abundance of nut taxa supports a fall occupation. However, the presence of a variety of wild seeds, tobacco, squash, and the channel catfish suggests that the site was also occupied during the spring and summer. The association of black walnut (*Juglans nigra*) with the Early Woodland component further suggests a late fall/winter occupation as processing of black walnuts is most efficient in early winter (Talalay et al. 1984).

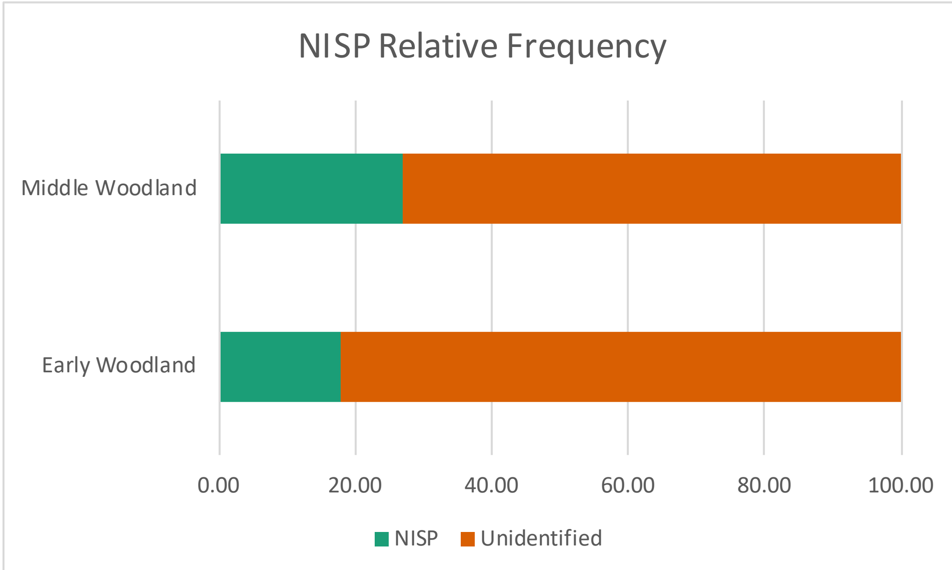


Figure 6.3. Relative frequency of faunal remains (by count) for the Early Woodland and Middle Woodland zooarchaeological assemblages.

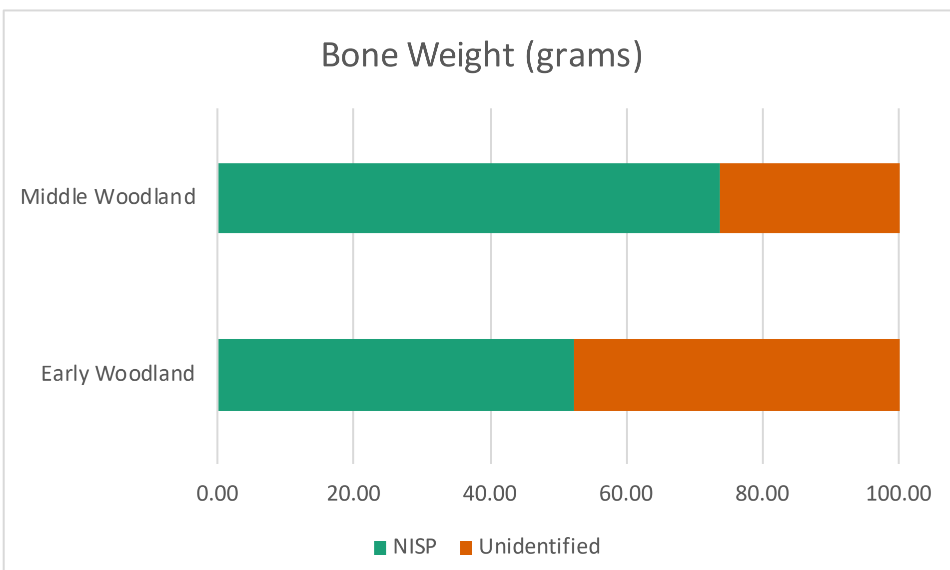


Figure 6.4. Relative frequency of faunal remains (by eight) based on bone weight for the Early Woodland and Middle Woodland zooarchaeological assemblages.

Table 6.8. Seasonal Availability of Plant Resources by Identified Species for the Early Woodland Component at the Finch Site.

Taxon	Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Juglans nigra	Black walnut									x	x	x	x
Quercus sp.	Acorn									x	x	x	
Cucurbita sp.	Squash (rind)					x	x	x	x	x			

Table 6.9. Seasonal Availability of Plant and Animal Resources by Identified Species for the Middle Woodland Component at the Finch Site.

Taxon	Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Carya sp.	hickory									x	x		
Carya cordiformis	bitternut hickory										x		
Corylus sp.	hazelnut									x	x	x	
Quercus sp.	acorn									x	x	x	
Euphorbia sp.	spurge				x	x							
Galium sp.	bedstraw					x	x	x	x				
Nicotiana sp.	tobacco						x	x	x	x	x	x	
Polygonum sp.	knotweed						x	x	x	x			
Cucurbita sp.	squash (rind)					x	x	x	x	x			
Ictalurus punctatus	channel catfish					x	x	x					

The plant and animal taxa suggest that the Early Woodland and Middle Woodland occupations of the Finch site occurred during the fall and early winter months. However, for the Middle Woodland component, the site was likely also inhabited not only during the fall but also over the spring and summer months. The greater length of time at the Finch site for the Middle Woodland site occupants is suggestive of decreased mobility and an increase in residential stability.

Plant Macroremain and Zooarchaeological Assemblage Composition

The plant macroremains and zooarchaeological assemblages are analyzed separately for the Early and Middle Woodland Finch site components relative to overall composition, taxon abundancy, and taxon ubiquity.

Plant Macroremain Assemblage

The analysis of the plant macroremain assemblages associated with the Early Woodland and Middle Woodland components at the Finch site is presented below. The description of the assemblages for each component are addressed separately and accomplished through identification of plant taxa and abundancy measures. Overall counts, weights and taxa are presented by field recovery technique. Composition of the assemblages, and relative contribution of taxa to the assemblage, are defined using descriptive statistics (based on counts) and the plant food ratio (q). Abundance is addressed through ubiquity and density measures. Following the description of the Early and Middle Woodland plant macroremain assemblages, the assemblages are formally compared based on composition, taxa abundance, and ubiquity.

Early Woodland Plant Macroremain Assemblage

A total of 482 fragments of charred plant material, weighing a total of 16.33 g, were recovered from cultural feature contexts associated with the Early Woodland component (Table 6.10, Table 6.11). The macroremains include an abundance of wood charcoal and low to moderate amounts of plant food (nuts, wild seeds, and squash rind) and other materials (fungus, resin, and unidentified

Table 6.10. Early Woodland Plant Macroremain Assemblage by Recovery Context

Taxon	Common Name	Flotation 350 liters		Non-Flotation		Total	
		Count	Weight (g)	Count	Weight (g)	Count	Weight (g)
Wood Charcoal							
All Wood		52	0.455	345	14.766	397	15.221
Plant Food							
Nutshell							
Juglandaceae	walnut	24	0.251	1	0.006	25	0.257
Juglans nigra	black walnut	0	0	24	0.554	24	0.554
Quercus sp.	acorn			10	0.028	17	0.05
Unidentified		0	0	6	0.11	6	0.11
Subtotal		24	0.251	41	0.698	65	0.949
Seeds							
cf Solanaceae	nightshade	1	0.001	0	0	1	0.001
Unidentifiable		1	0.001	0	0	1	0.001
Subtotal		2	0.002	0	0	2	0.002
Squash							
Cucurbita sp.	squash rind	0	0	2	0.017	2	0.017
Subtotal Plant Food		26	0.253	43	0.715	69	0.968
Other							
Unidentified		8	0.094	3	0.029	11	0.123
Resin		3	0.011	0	0	3	0.011
Rhizome		0	0	0	0	0	0
Fungus		2	0.002	0	0	2	0.002
Subtotal Other		13	0.107	3	0.029	16	0.136
Grand Total		91	0.815	391	15.51	482	16.325

Table 6.11. Composition of the Early Woodland Plant Food Assemblage

Type	Count	Weight (g)	Percent Count	Plant Food Ratio (*q*) Count : Total Plant Weight
Nutshell	65	0.949	94.20	67.15
Seed	2	0.002	2.90	2.07
Cucurbit	2	0.017	2.90	2.07
Total	69	0.968	100.00	71.28

materials). Domesticates, consisting of a few fragments of squash (*Cucurbita* sp.) are present in the plant macroremain assemblage.

The wood charcoal assemblage consists of 397 fragments, weighing 15.221 g, and was recovered from flotation samples as well as non-flotation recovery techniques (Table 6.10). Wood charcoal was present in nine of the Early Woodland features, having a ubiquity value of 0.50. Density measures, limited to wood charcoal derived from the flotation samples, averages 1.46 fragments per ten liters. By weight, wood charcoal density is 0.01 g per ten liters of processed matrix.

The plant food assemblage is characterized by very high densities of nutshell, representing 94.20 percent of the assemblage by overall count, and very low densities of squash rind and wild seeds (Table 6.11).The high plant food ratio (*q*) further underscores the substantial contribution of nuts, as compared to wild seeds and squash, in the Early Woodland plant food assemblage (Table 6.11).

Four taxa are present in the plant food assemblage, consisting of two nut varieties, squash rind (*Cucurbita* sp.), and one wild fruit seed identifiable only to the nightshade (cf Solanaceae) family (Table 6.10). The nut taxa represented in the assemblage include black walnut (*Juglans nigra)* and acorn (*Querus* sp.). Several nutshell fragments identifiable only to the walnut (Juglandaceae) family are present as are unidentified nutshells. Of the identified nut taxa, 42.37 percent are of the walnut (Juglandaceae) family, 40.68 percent are black walnut (*Juglans nigra)*, and 16.95 percent are acorn (*Quercus* sp.) (Table 6.12). Comparing nutshell at the family level, thus combining the black walnut (*Juglans nigra*) and the nutshell identifiable only as walnut family (Juglandaceae) into one category, fully 83.05 percent of the Early Woodland nutshell represents the walnut (Juglandaceae) family.

Based on the plant macroremains recovered from the cultural feature flotation samples, the Early Woodland plant food assemblage exhibits a very low density, averaging less than one fragment (0.74) of plant remains per ten liters of soil matrix (Table 6.13). In all, only 26 fragments, weighing 0.253 g, of plant macroremains were recovered from 350 liters of feature matrix. Nutshell density

Table 6.12. Taxonomic Representation of the Early Woodland Nutshell Assemblage

Taxon	Common Name	Count	Weight (g)	Percent Count
Quercus sp.	acorn	10	0.028	16.95
Juglans nigra	black walnut	24	0.554	40.68
Juglandaceae	walnut	25	0.257	42.37
Total		59	0.839	100.00

Table 6.13. Plant Food Density for the Early Woodland Macroremain Assemblage

	Count	Weight (g)	Density (*d*) (count)	Density (*d*) (weight)
Nutshell	24	0.251	0.69	<0.01
Seed	2	0.002	0.06	<0.01
Cucurbit	--	--	--	--
Total	26	0.253	0.74	<0.01

Note: Density data based on plant macroremains recovered from flotation samples (350 liters). Density values are counts or weight per ten liters.

is low, averaging only 0.7 fragments per ten liters. Seed density is extremely low, averaging 0.1 seed per 10 liters. Squash (*Cucurbita* sp.) rind was not recovered from flotation contexts precluding a density measure for this plant type.

Ubiquity values indicate that nutshell is the most ubiquitous taxa, occurring in 39 percent of the Early Woodland features (Table 6.14, Table 6.15). Based on taxonomic representations, black walnut (*Juglans nigra)* and nutshell of the walnut (Juglandaceae) family are the most ubiquitous, occurring in 17 percent of the features. *Cucurbita* sp. rind occurs in two features with a ubiquity value of 11 percent. Acorn (*Quercus* sp.) nutshell, the cf Solanaceae (nightshade family) seed, and unidentifiable seeds have the lowest ubiquity values each occurring in only one feature.

Middle Woodland Plant Macroremain Assembalge

A total of 1266 fragments of charred plant material, weighing a total of 34.786 g, were recovered from cultural feature contexts associated with the Middle Woodland component (Table 6.16). The macroremains include an abundance of wood charcoal and low to moderate amounts of plant food (nuts, wild seeds, and squash rind) and other materials (fungus, resin, and unidentified materials). Domesticates are present in the assemblage and consist of squash (*Curcurbita* sp.) rind and tobacco (*Nicotiania* sp.). By relative frequencies (of counts), wood charcoal composes 77.01 percent of the assemble, plant foods total 13.35 percent, and other remains represent 9.64 percent (Table 6.17).

The wood charcoal assemblage consists of 975 fragments, weighing 31.077 g, recovered by flotation samples as well as non-flotation techniques (Table 6.16). A total of 17 Middle Woodland features yielded wood charcoal resulting in an ubiquity value of 0.81. Density measures, limited to wood charcoal derived from the flotation samples, averages 18.18 fragments per ten liters of processed soil matrix. By weight, wood charcoal density is 0.15 g per ten liters of processed matrix.

A total of nine taxa are represented in the Middle Woodland plant food assemblage including four nutshell taxa, four wild seed varieties, and squash rind (Table 6.16). The plant food assemblage

Table 6.14. Ubiquity Values of the Early Woodland Plant Food Assemblage

Description	Number of Features Present	Ubiquity Value (*U*)
Nutshell	7	0.39
Seed	1	0.06
Cucurbit	2	0.11

Table 6.15. Ubiquity Values of the Early Woodland Plant Food Assemblage By Taxa

Taxon	Common Name	Number of Features Present	Ubiquity Value (*U*)
Nutshell			
Junglas nigra	black walnut	3	0.17
Juglandaceae	walnut	3	0.17
Quercus sp.	acorn	1	0.06
Seeds			
Solanaceae	nightshade	1	0.06
Unidentifiable		1	0.06
Squash			
Curcurbita sp.	squash (rind)	2	0.11

Table 6.16. Middle Woodland Plant Macroremain Assemblage by Recovery Context

Taxon	Common Name	Flotation 198 liters		Non-Flotation		Total	
		Count	Weight (g)	Count	Weight (g)	Count	Weight (g)
Wood Charcoal							
All Wood		360	2.957	615	28.12	975	31.077
Plant Food							
Nuts							
Carya sp.	hickory	52	0.802	30	0.332	82	1.134
Carya cordiformis	bitternut hickory	2	0.052	--	--	2	0.052
Corylus sp.	hazelnut	3	0.031	--	--	3	0.031
Juglandaceae	walnut	2	0.027	6	0.154	8	0.181
Quercus sp.	acorn	12	0.023	24	0.186	36	0.209
Unidentified		0	0	4	0.03	4	0.03
Nutmeat		3	0.018	0	0	3	0.018
Subtotal		74	0.953	64	0.702	138	1.655
Seeds							
Euphorbia sp.	spurge	3	0.005	--	--	3	0.005
Galium sp.	bedstraw	--	--	1	0.007	1	0.007
Nicotiana sp.	tobacco	8	0.001	--	--	8	0.001
Polygonum sp.	knotweed	1	0.002	--	--	1	0.002
Unidentifiable		2	0.002	2	0.002	4	0.004
Subtotal		14	0.01	3	0.009	17	0.019
Cucurbits							
Cucurbita sp.	squash (rind)	1	0.004	13	0.186	14	0.19
Total Plant Food		89	0.967	80	0.897	169	1.864
Other							
Unidentified		66	1.307	46	0.38	112	1.687
Resin		1	0.006	2	0.013	3	0.019
Rhizome		7	0.139	--	--	7	0.139
Total Other		74	1.452	48	0.393	122	1.845
Grand Total		523	5.376	743	29.41	1266	34.786

Note: All nuts represent nutshell fragments except for the nutmeats.

Table 6.17. Relative Frequency of the Middle Woodland Plant Macroremain Assemblage by Type

Description	Count	Weight (g)	Percent Count
Wood Charcoal	975	31.077	77.01
Plant Food	169	1.864	13.35
Other	122	1.845	9.64
Total	1266	34.786	100.00

consists of high quantities of nuts and low to moderate amounts of wild seed varieties and squash rind. Nuts dominate the plant food assemblage, representing 81.66 percent, by count, of the total assemblage. Wild seeds and squash rind respectively compose 10.06 percent and 8.28 percent of the assemblage (Table 6.18). The ratio of taxa counts to total plant weight further underscores the importance of nuts relative to the Middle Woodland plant foods (Table 6.18). The nutshell ratio measures 74.03 as compared to the values for wild seeds and curcurbits that are both below ten.

The nut taxa represented in the assemblage consist of hickory (*Carya* sp.), acorn (*Quercus* sp.), bitternut hickory (*Carya cordiformis*) and hazelnut (*Corylus* sp.) (Table 6.19). Also present in the assemblage are several fragments that could only be identified to the Juglandaceae (walnut) family, unidentifiable taxa, and nutmeats (Table 6.16). The relative frequencies (by count) of the nutshell assemblage identified to taxa indicates an abundance of hickory (*Carya* sp.) nutshell,

Table 6.18. Relative Frequency of the Middle Woodland Plant Food Assemblage

Description	Count	Weight (g)	Percent Count	Plant Food Ratio (*q*) Count : Total Plant Weight
Nutshell	138	1.655	81.66	74.03
Seed	17	0.019	10.06	9.12
Squash	14	0.19	8.28	7.51
Total	167	1.864	100.00	90.67

Table 6.19. Relative Frequency of the Middle Woodland Nutshell Assemblage Identified Taxa

Taxon	Common Name	Count	Weight (g)	Percent Count	Plant Food Ratio (*q*) Count : Total Plant Weight
Carya sp.	hickory	82	1.134	62.60	70.57
Carya cordiformis	bitternut hickory	2	0.052	1.53	3.24
Juglandaceae	walnut family	8	0.181	6.11	11.26
Corylus sp.	hazelnut	3	0.031	2.29	1.93
Quercus sp.	acorn	36	0.209	27.48	13.01
Total		131	1.607	100.00	100.00

moderate moderate amounts of acorn (*Quercus* sp.) nutshell, and very low quantities of bitternut hickory (*Carya cordiformis*), hazelnut (*Corylus* sp.), and nutshell of the Juglandaceae (walnut) family. The ratios of nutshell taxa count to total plant weight further inform on the relative value of specific taxa to the overall plant food assemblage. Based on the ratios, hickory and acorn nuts contribute more heavily to the plant food assemblage as compared to bitternut hickory, hazelnut, and nuts of the walnut family (Table 6.19).

Seeds represented in the Middle Woodland plant food assemblage consist of two taxa related to weed seeds (spurge and bedstraw), one taxa related to grain/oil seeds and greens (knotweed) and tobacco (Table 6.16). The single knotweed (*Polygonum* sp.) seed is fragmentary precluding a clear assessment of size and surface texture (Mueller 2018); whether the seed represents a wild form or a domesticate is indeterminate. Four unidentifiable seeds are also present in the assemblage. Given the low frequency of weed seed and grain/oil seeds and greens, these seed types likely were incidental inclusions in the feature matrix. In contrast, all of the tobacco seeds were recovered from one feature (feature 37) and reflects cultural patterning. Feature 37, unfortunately, did not yield culturally diagnostic materials so the association of tobacco seeds with the Middle Woodland occupation remains equivocal.

The Middle Woodland plant food assemblage, derived from the flotation samples, exhibits an average density of less than five fragments of plant remains per 10 liters of soil matrix (Table 6.20). Among the plant food categories (nuts, seed, squash rind), nutshell has the highest density of 3.7 fragments per 10 liters of soil. Seeds and squash rind occur in very low densities across the site, averaging less than one fragment per 10 liters of soil.

Ubiquity values indicate that nutshell is the most ubiquitous plant food type in the Middle Woodland assemblage, occurring in 67 percent of the Middle Woodland features (Table 6.21). Squash rind and seeds have ubiquity values of 19 percent. Ranking the identified plant remains by ubiquity values indicates that the top five most ubiquitous taxa are hickory (*Carya* sp.) nutshell, acorn (*Quercus* sp.) nutshell, squash rind *(Cucurbita* sp.), and nutshell of the walnut (Juglandaceae)

Table 6.20. Density Measures of the Middle Woodland Plant Food Assemblage

Description	Count	Weight (g)	Density (*d*) (count)	Density (*d*) (weight)
Nutshell	74	0.953	3.74	0.05
Seed	14	0.01	0.71	<0.01
Squash rind	1	0.004	0.05	<0.01
Total	89	0.967	4.49	0.05

Note: Density calculations based on plant macroemains recovered from the flotation samples totaling 198 liters and indicate count or weight per ten liters.

Table 6.21. Ubiquity Values of the Middle Woodland Plant Food Assemblage by Type

Description	Number of Features Present	Ubiquity Value (*U*)
Nutshell	14	0.67
Seed	4	0.19
Squash (rind)	4	0.19

family / hazelnut (*Corylus* sp.) nutshell (tied for fourth place) (Table 6.22). Note that the two features containing walnut (Juglandaceae) family nutshell are different than the features containing hickory (*Carya* sp.) nutshell indicating that, as a family, Juglandaceae (walnut) would have a ubiquity value of 52.3 percent.

Comparative Analysis of the Early and Middle Woodland Plant Macroremain Assemblages

The Early Woodland and Middle Woodland plant macroemain assemblages are compared in terms of overall assemblage composition, abundance, and ubiquity measures. Comparing the relative frequencies of the overall plant macroremain assemblages associated with the Early Woodland and Middle Woodland components indicates overall similarities (Figure 6.5; Figure 6.6). Both components are associated with very high frequencies of wood charcoal, moderate to low amounts of plant food, and low quantities of other plant remains (Figure 6.5). The Early Woodland assemblage has a slightly higher frequency of wood charcoal and plant foods, and lower frequency of other plant types, than the Middle Woodland assemblage.

Table 6.22. Ubiquity Values of the Middle Woodland Plant Food Assemblage by Taxon

Taxon	Common Name	Number of Feature Present	Ubiquity Value (*U*)
Carya sp.	hickory	9	0.43
Quercus sp.	acorn	5	0.24
Cucurbita sp.	squash (rind)	4	0.19
Juglandaceae	walnut (family)	2	0.10
Corylus sp.	hazelnut	2	0.10
Carya cordiformis	bitternut hickory	1	0.05
Nutmeat	--	1	0.05
Euphorbia sp.	spurge	1	0.05
Galium sp.	bedstraw	1	0.05
Nicotiana sp.	tobacco	1	0.05
Polygonum sp.	knotweed	1	0.05

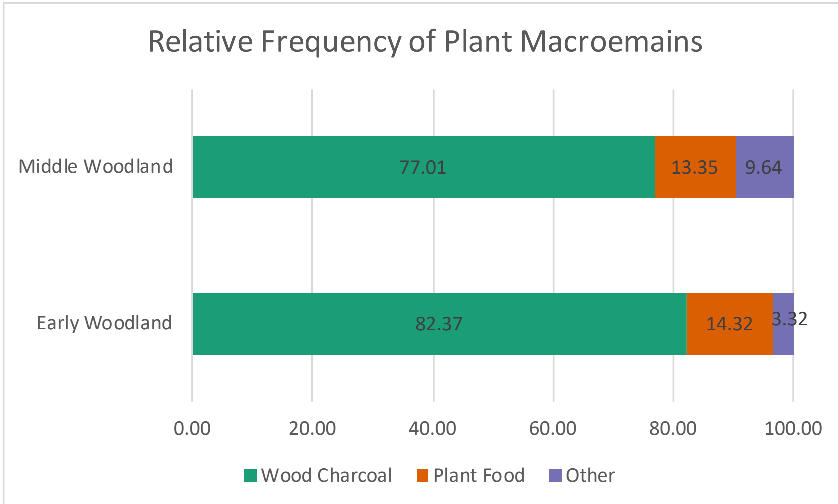


Figure 6.5. Relative frequency of the plant macroremain assemblage composition associated with the Early Woodland and Middle Woodland components (all recovery contexts).

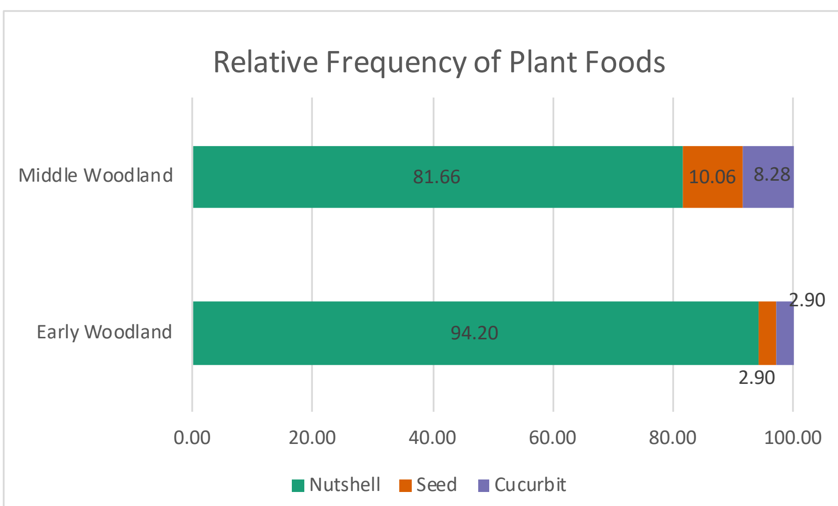


Figure 6.6. Relative frequency of the plant food assemblage composition associated with the Early Woodland and Middle Woodland components (all recovery contexts).

Both the Early and Middle Woodland plant macroremain assemblages have relatively high frequencies of wood charcoal. However, ubiquity and density measures indicate that wood charcoal is more abundant in the Middle Woodland assemblage compared to the Early Woodland component (Table 6.23). Using the plant macroremains derived solely from the flotation samples, wood charcoal occurs in 81 percent of the Middle Woodland features as compared to 53 percent of the Early Woodland features. Density measures reveal that wood charcoal from Middle Woodland feature average 18.18 fragments per ten liters of processed matrix as compared to 1.46 fragments per ten liters for the Early Woodland features. Density, using wood charcoal weight, exhibits the same patterning. This difference in wood charcoal may explain why there are so few charred plant macroemains for the Early Woodland component as compared to the Middle Woodland component. More features with fire for Middle Woodland component is correlated with a greater opportunity for plant foods to become charred and preserved in the archaeological record and thus available for recovery.

Focusing on the plant food assemblage, the relative frequencies associated with the Early and Middle Woodland components indicate an overall similarity. Both components exhibit high frequencies of nutshell with low to moderate percentages of wild seed taxa and cucurbit rind (Figure 6.6). The Early Woodland assemblage has higher frequencies of nutshell as compared to the Middle Woodland assemblage. The Middle Woodland plant food assemblage exhibits higher frequencies of wild seed taxa and cucurbit than the Early Woodland plant food assemblage.

The plant food ratio (q) of plant food count to total plant food weight is calculated for nutshell, seeds, and squash rind associated with the Early Woodland and Middle Woodland contexts (Table 6.24). Overall, the Early and Middle Woodland assemblage exhibit an overall similar pattern in that nuts are the main contributor to the plant food assemblage. Nutshell is the dominant constituent of both the Early Woodland and Middle Woodland assemblage, although its overall contribution to the plant food assemblage is slightly higher during the Middle Woodland as compared to the Early Woodland data. In the Middle Woodland assemblage, wild seeds and cucurbits contribute

Table 6.23. Density and Ubiquity Measures for Wood Charcoal Derived from the Flotation Samples

Component	Count	Weight (g)	Density (*d*) (count)	Density (*d*) (weight)	Ubiquity (*U*)
Early Woodland	52	0.455	1.46	0.01	0.53
Middle Woodland	360	2.957	18.18	0.15	0.81

Note: Density calculations based on plant macroemains recovered from the flotation samples indicate count or weight per ten liters.

Table 6.24. Plant Food Ratio (Counts to Total Plant Food Weight) by Type for the Early Woodland and Middle Woodland Plant Macroremain Assemblages

Description	Early Woodland	Middle Woodland
Nutshell	67.15	74.03
Seed	2.07	9.38
Cucurbit	2.07	7.73

moderately to the plant food assemblage. In the Early Woodland assemblage, wild seeds and curcurbits are minor components of the plant food assemblage.

Given the composition of the plant food assemblages, it is only reasonable to compare the relative abundance of nutshell within the Early and Middle Woodland assemblage. Too few seeds and squash rind fragments were recovered from either component to allow for meaningful statistical comparison of abundancy.

The pattern of nutshell abundance is illustrated with boxplots that display and compare the frequency distribution for nutshell (Figure 6.7). The boxplot shown in Figure 6.7 includes those features where nutshell count was greater than zero. For the Early Woodland contexts, seven features are included and for the Middle Woodland context 14 features are included in the analysis.

The box plots indicate a similar range for the *nutshell count: plant weight* ratios and also have medians that are very similar. Although the Middle Woodland data identify one outlier, from feature 48, the value results from a few nutshell fragments that were exceptionally light, thus skewing the data (Appendix L). As the notches for the Early and Middle Woodland nutshell ratios overlap, the samples are not significantly different at the 0.05 confidence level. As such, the standardized ratios for nutshell do not indicate any statistically significant differences in nutshell abundance between the Early Woodland and Middle Woodland assemblages.

The ubiquity values for nutshell, seeds, and squash are compared for the Early Woodland and Middle Woodland study assemblage (Table 6.25). Middle Woodland ubiquity values for nutshell, seeds, and squash are higher than those values for Early Woodland. The differences in the ubiquity values for the seeds and squash should be tempered by the small amounts of these plant foods recovered from the study assemblages. Many of the wild seeds may also represent incidental inclusions in the feature fill; seeds may also be underrepresented owing to taphonomic processes (Tryon 2006). Nonetheless, seeds and squash have a higher ubiquity in the Middle Woodland

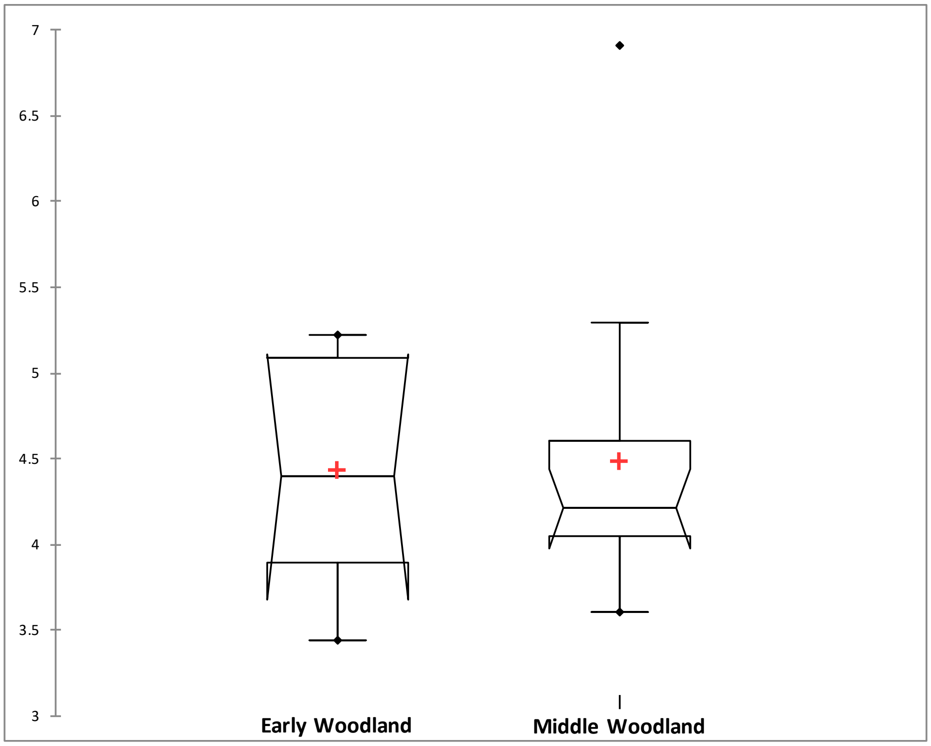


Figure 6.7. Boxplots comparing relative abundance of nutshell in Early Woodland and Middle Woodland contexts. Values are standardized counts reexpressed as natural logarithms of the plant food ratio (ln[*q*]). Sample sizes are: Early Woodland n=7, Middle Woodland n=14. Data is included as Appendix L.

Table 6.25. Ubiquity Values of the Early Woodland and Middle Woodland Plant Macroremain Assemblage by Type

	Early Woodland		Middle Woodland	
	Number of Features Present	Ubiquity Value (*U*)	Number of Features Present	Ubiquity Value (*U*)
Nutshell	7	0.39	14	0.67
Seed	1	0.06	4	0.19
Squash	2	0.11	4	0.19

Note: There are 18 features associated with the Early Woodland component and 21 Middle Woodland features.

assemblages than in Early Woodland assemblage, suggesting an increased use, or frequency of use, within these plant resources during the Middle Woodland.

The top five most ubiquitous taxa for the Early Woodland and Middle Woodland assemblages reveals similar patterning (Table 6.26). The five most ubiquitous plant food taxa for the Early Woodland assemblage consists of, in descending importance, black walnut (*Juglans nigra*), hickory/walnut (Juglandaceae), squash rind (*Curcurbita* sp.), acorn (*Quercus* sp.), and seeds of the nightshade (Solanaceae) family (Table 6.26). The five most ubiquitous taxa for the Middle Woodland assemblage consists of hickory (*Carya* sp.), acorn (*Quercus* sp.), squash rind (*Cucurbita* sp.), hickory/walnut (Juglandaceae), and hazelnut (*Corylus* sp.). The top four most ubiquitous taxa are the same for both the Early Woodland and Middle Woodland assemblages.

The highest ranked ubiquity values for the Early and Middle Woodland assemblages belong to nutshell varieties of the hickory/walnut (Juglandaceae) family, which includes hickory (*Carya* sp.) and black walnut (*Juglans nigra*), acorn (*Quercus* sp.) nutshell, and squash (*Cucurbit* sp.) rind. The difference between the assemblages is that black walnut and Solanaceae seeds are represented in the Early Woodland assemblage and are not among the top five most ubiquitous Middle Woodland taxa; hickory (*Carya* sp.) and hazelnut (*Corylus* sp.) are within the top five

Table 6.26. Top Five Ranked Ubiquity Values of the Early Woodland and Middle Woodland Plant Food Assemblage

Early Woodland				Middle Woodland			
Rank	Taxon	Number of Feature Present	Ubiquity Value (*U*)	Rank	Taxon	Number of Features Present	Ubiquity Value (*U*)
1	*Juglans nigra*	3	0.17	1	*Carya* sp.	9	0.43
2	Juglandaceae	3	0.17	2	*Quercus* sp.	5	0.24
3	Curcurbit sp.	2	0.11	3	Cucurbit sp.	4	0.19
4	*Quercus* sp.	1	0.06	4	Juglandaceae	2	0.10
5	Solanaceae	1	0.06	5	*Corylus* sp.	2	0.10

more ubiquitous Middle Woodland taxa but are not the top five top ranked Early Woodland taxa. Nonetheless both Early and Middle Woodland assemblages are characterized by high frequencies of hickory/walnut family nutshell, acorn nutshell, and squash.

Zooarchaeological Assemblages

The description of the zooarchaeological assemblages associated with the Early and Middle Woodland components at the Finch site are provided below. Composition of the assemblage, abundance measures, and bone modification are used to describe the Early Woodland and Middle Woodland zooarchaeological assemblages. Three techniques, NISP, bone weight, and mammal size classification, are employed to characterize the assemblage composition. Abundance is measured through descriptive statistics, based on NISP and bone weight, and ubiquity values.

Early Woodland Zooarchaeological Assemblage

The zooarchaeological assemblage associated with the Early Woodland component consists of 4096 fragments weighing a total of 452.50 grams (Table 6.27). Of this total, 17.80 percent (by NISP) and 52.34 percent (by weight) are identifiable to taxonomic class. The majority of the remains, fully 82.20 percent (by NISP) or 47.66 percent (by weight) are unidentifiable.

Table 6.27. The Early Woodland Zooarchaeological Assemblage

Taxon	Total		Percent	
	Count	Weight	Count	Weight
Identified				
Bird	2	0.69	0.05	0.15
Fish	37	0.87	0.90	0.19
Mammal	653	231.55	15.94	51.17
Reptile	34	3.67	0.83	0.81
Bivalve	3	0.05	0.07	0.01
Subtotal Identified	729	236.83	17.80	52.34
Unidentified	3367	215.67	82.20	47.66
Grand Total	4096	452.5	100.00	100.00

A total of five species are identifiable in the Early Woodland assemblage. Species identification is limited to the mammal and reptile taxons. None of the faunal remains classified as bird or fish are identifiable to species. Mammal species include even-toed ungulate (Artiodactyl), wolf/coyote/dog (Canis), elk (*Cervus canadensis)*, and white-tailed deer (*Odocoileus virginianus)*. Specimens typed as Artiodactyl most likely represent white-tailed deer (*Odocoileus virginianus)* (Stencil 2015:109). The reptile is turtle (Testudines).

The identifiable assemblage is characterized by very high frequencies of mammal remains, low to moderate amounts of fish and reptiles, and very low quantities of birds and bivalves (Table 6.27; Table 6.28). Mammals represent 89.94 percent by NISP and 97.79 percent by weight of all identified specimens in the zooarchaeological assemblage (Table 6.28). Mammal species include even-toed ungulate (Artiodactyl), wolf/coyote/dog (Canis), elk (*Cervus canadensis)*, and white-tailed deer (*Odocoileus virginianus)* (Table 6.29).

Of the non-mammalian taxonomic classes (birds, reptiles, and fish), only a few reptile fragments are identifiable to taxonomic class. Reptiles, all identified as turtle (Testudines), compose 4.68 percent by NISP and 1.55 by weight (Table 6.28). Fish represent 5.10 percent by NISP and 0.37 percent by weight. Finally, birds, all unidentified, total 0.28 percent by NISP and 0.29 by weight (Table 6.29).

Although many of the mammal remains in the assemblage are unidentifiable to species, many are classifiable by size (Stencil 2015). In all, fully 83 percent (by count) could be assigned a size classification (Table 6.30). The size-identified mammal assemblage is dominated by medium/large mammals and large mammals which together compose 97.23 percent of the assemblage. Medium mammals total 5.90 percent of the assemblage and small mammals represent only 0.92 percent.

Ubiquity values indicate that mammals are the most ubiquitous taxa, occurring in 59.3 percent of all contexts (Table 6.31). Testudines follow in presence frequency with a value of 18.5 percent. Least ubiquitous are fish and bird.

Table 6.28. Relative Frequency of the Identified Specimens in the Early Woodland Zooarchaeological Assemblage

Taxon	NISP	Weight (g)	Percent NISP	Percent Weight (g)
Bird	2	0.69	0.28	0.29
Fish	37	0.87	5.10	0.37
Mammal	653	231.55	89.94	97.79
Reptile	34	3.67	4.68	1.55
Total	726	236.78	100.00	100.00

Table 6.29. Identified Species in the Early Woodland Zooarchaeological Assemblage

Taxon - Species	Common Name	Count	Weight (g)
Bird			
Unidentified	--	2	0.69
Fish			
Unidentified	--	37	0.87
Mammal			
Artiodactyl	even-toed ungulate	2	1.83
Canis	wolf/coyote/dog	2	2.82
Cervus canadensis	elk	2	0.86
Odocoileus virginianus	white-tailed deer	9	42.37
Unidentified		638	183.67
Reptile			
Testudines	turtle	34	3.67
Total NISP		726	236.78

Table 6.30. Mammal Size Classifications for the Early Woodland Zooarchaeological Assemblage

Size	Count	Weight (g)	Percent Count	Percent Weight (g)
Small	5	0.41	0.92	0.20
Medium	10	4.2	1.85	2.04
Large	32	63.61	5.90	30.84
Medium/Large	495	138.05	91.33	66.93
Total	542	206.27	100.00	100.00

The types of animals represented in the Early Woodland assemblage indicate local procurement of resources from the area containing and surrounding the Finch site. All of the identified mammal species, especially the presence of white-tailed deer, could be found in the oak openings and oak forest ecological zones near the site (Stencil 2015). Various species of turtles (Testudines) would have been available in all of the ecological zones surrounding the Finch site (Stencil 2015).

Middle Woodland Zooarchaeological Assemblage

The zooarchaeological assemblage associated with the Middle Woodland component consists of 4600 fragments of faunal material weighing a total of 798.92 grams (Table 6.32). Of this total, 27.04 percent (by count) and 73.62 percent (by weight) are identifiable to taxonomic class. The majority of the remains, fully 72.96 percent (by count) or 26.38 percent (by weight) are unidentifiable.

A total of eight species are represented in the assemblage including channel catfish (*Ictalurus punctatus)*, even-toed ungulate (Artiodactyl), striped skunk (*Mephitis mephitis)*, muskrat (*Ondatra zibethicus*), raccoon (*Procyon lotor)*, white-tailed deer (*Odocoileus virginianus)*, and turtle (Testudines) (Table 6.33). The even-toed ungulate (Artiodactyl) remains likely represent white-

Table 6.31. Ubiquity Values for the Early Woodland Zooarchaeological Assemblage

Taxon	Common Name	Total Present	Total Ubiquity
Bird	unidentified	1	0.019
Fish	unidentified	3	0.056
Mammal			
Artiodactyl	even-toed ungulate	2	0.037
Canis	wolf	1	0.019
Cervus canadensis	elk	1	0.019
Odocoileus virginianus	white-tailed deer	6	0.111
Unidentified	--	31	0.574
All Mammal	--	32	0.593
Reptile			
Testudines	turtle	10	0.185

tailed deer (*Odocoileus virginianus* (Stencil 2015:109). The bird remains are not identifiable to species.

The identifiable assemblage is characterized by very high frequencies of mammal remains and very low quantities of reptiles, fish, and bird (Table 6.32; Table 6.34). Mammals contribute 96.38 percent by NISP and 99.48 percent by bone weight. Reptiles compose 1.13 percent by count and 0.37 percent by weight. Fish contribute 2.33 percent by NISP and 0.10 percent by weight. Birds represent 0.16 percent by NISP and 0.05 percent by weight.

Although many of the mammal remains in the assemblage are unidentifiable to species, many are classifiable by size (Stencil 2015). Of the mammal remains, fully 90.65 percent (by count) are assigned a size classification. The size-identified mammal assemblage is dominated by medium/large mammals and large mammals which together compose 89.41 percent of the assemblage (Table 6.35). Medium mammals total 1.08 percent of the assemblage and small mammals represent only 0.15 percent.

Table 6.32. The Middle Woodland Zooarchaeological Assemblage

Taxon	Total		Percent	
	Count	Weight (g)	Count	Weight (g)
Identified				
Bird	2	0.29	0.04	0.04
Fish	29	0.61	0.63	0.08
Mammal	1199	585.06	26.07	73.23
Reptile	14	2.18	0.30	0.27
Subtotal Identified	1244	588.14	27.04	73.62
Unidentified	3356	210.781	72.96	26.38
Grand Total	4600	798.921	100.00	100.00

Table 6.33. Identified Species in the Middle Woodland Zooarchaeological Assemblage

Taxon	Common Name	Count	Weight (g)
Bird			
Unidentified	--	2	0.29
Fish			
Ictalurus punctatus	channel catfish	1	0.2
Unidentified	--	28	0.41
Mammal			
Artiodactyl	even-toed ungulate	3	5.18
*Mephitis mephiti*s	striped skunk	1	0.9
Ondatra zibethicus	muskrat	1	1.29
Procyon lotor	raccoon	2	2.28
Odocoileus virginianus	white-tailed deer	34	93.38
Unidentified	--	1158	482.03
Reptile			
Testudine	turtle	14	2.18
Total NISP		1244	588.14

Table 6.34. Relative Frequency of the Identified Specimens in the Middle Woodland Zooarchaeological Assemblage by NISP and Bone Weight

Description	Count	Weight (g)	Percent Count	Percent Weight
Bird	2	0.29	0.16	0.05
Fish	29	0.61	2.33	0.10
Mammal	1199	585.06	96.38	99.48
Reptile	14	2.18	1.13	0.37
Total	1244	588.14	100.00	100.00

Table 6.35. Mammal Size Classifications for the Middle Woodland Zooarchaeological Assemblage

	Count	Weight (g)	Percent Count	Percent Weight
Small	5	0.89	0.42	0.15
Medium	6	6.33	0.50	1.08
Large	153	230.6	12.76	39.41
Medium/Lage	765	292.55	63.80	50.00
Subtotal	929	530.37	77.48	90.65
Indeterminate	270	54.69	22.52	9.35
Grand Total	1199	585.06	100.00	100

Ubiquity values indicate that mammals are the most ubiquitous taxa, occurring in 44.1 percent of all contexts (Table 6.36) . Testudines follow in presence frequency with a value of 10.3 percent. Least ubiquitous are fish and bird.

The types of animals represented in the Middle Woodland assemblage indicate local procurement of resources from the area containing and surrounding the Finch site. All of the identified mammal species, especially the presence of white-tailed deer, could be found in the oak openings and oak forest ecological zones surrounding the site (Stencil 2015). The most common mammal species identified is white-tailed deer suggesting that the oak openings and oak forest ecological zones were used for large mammal procurement (Stencil 2015). The presence of raccoon, an opportunistic predator that exploits wooded areas near streams, ponds, and marshes, as well as muskrat, indicates a Wetland zone exploitation of resources by Middle Woodland inhabitants of the site. The fish taxon, including the channel catfish (*Ictalurus punctatus)*, indicates use of the aquatic ecological zone that is present in Lake Koshkonong and the Rock River. One species of reptile is present in the assemblage, Testudines (turtle). Various species of Testudines would have been available in all of the ecological zones surrounding the Finch site (Stencil 2015).

Comparative Analysis of the Early Woodland and Middle Woodland Zooarchaeological Assemblages

The Early and Middle Woodland assemblages contain bird, fish, mammal, and reptile taxa (Table 6.37). The Early Woodland assemblage includes bird (unidentified), fish (unidentified), four mammal taxa, and reptiles that all have been identified as turtle (Testudines). The mammal taxa consist of even-toed ungulate (Artiodactyl), wolf/coyote/dog (Canis), elk (*Cervus canadensis*), and white-tailed deer (*Odocoileus viginianaus*) as well as unidentifiable mammal specimens. Ecological zones represented by the Early Woodland taxa include prairie, oak/deciduous forests, oak openings, and aquatic/wetlands.

The Middle Woodland assemblage includes bird (unidentified), one identified fish taxa, five mammal taxa, and reptiles that all have been identified as turtle (Testudines) (Table 6.37). The

Table 6.36. Ubiquity Values for the Middle Woodland Zooarchaeological Assemblage

Taxon	Common Name	Total Present	Total Ubiquity
Bird		2	0.029
Fish			
Ictalurus punctatus	channel catfish	1	0.015
Unidentified	--		
All Fish	--	5	0.074
Mammal			
Artiodactyl	even-toed ungulate	1	0.015
Mephitis mephitis	striped skunk	1	0.015
Ondatra zibethicus	muskrat	1	0.015
Procyon lotor	raccoon	2	0.029
Odocoileus virginianus	white-tailed deer	7	0.103
Unidentified	--	29	0.426
All Mammal	--	30	0.441
Reptile			
Testudines	turtle	7	0.103

Table 6.37. Taxa and Ecological Zones/Habitats of the Early Woodland and Middle Woodland Zooarchaeological Assemblages

Taxa - Species	Common Name	Ecological Zone	Early Woodland	Middle Woodland
Bird				
Unidentified	--	--	x	x
Fish				
Ictalurus punctatus	Channel catfish	Aquatic/Wetlands		x
Unidentified	--	--	x	x
Mammal				
Artiodactyl	even-toed ungulage	Oak openings & Oak Forest	x	x
Canis	wolf/coyote/dog	Prairies; Oak/Deciduous Forests; Oak Openings	x	
Cervus canadensis	elk	Prairies; Oak/Deciduous Forests; Oak Openings	x	
Mephitis mephitis	striped skunk	Oak/Deciduous Forests; Oak Openings		x
Odocoileus virginianus	white-tailed deer	Oak/Deciduous Forests; Oak Openings	x	x
Ondatra zibethicus	muskrat	Aquatic/Wetland		x
Procyon lotor	raccoon	Oak openings & Oak Forest; Aquatic/Wetland		x
Unidentified	--	--		
Reptile				
Testudines	turtle	Prairie; Oak/Deciduous Forests; Aquatic/Wetland; Oak Openings	x	x

fish taxa is channel catfish (*Ictalurus punctatus*); unidentifiable fish remains are also present. The mammal taxa consist of even-toed ungulate (Artiodactyl), striped skunk (*Mephitis mephitis*), muskrat (*Ondatra zibethicus*), raccoon (*Procyon lotor*), and white-tailed deer (*Odocoileus viginianaus)* as well as unidentifiable mammal specimens. Ecological zones represented by the Middle Woodland taxa include prairie, oak/deciduous forests; oak openings, and aquatic/wetlands.

The Early Woodland and Middle Woodland assemblages are similar in having unidentified birds, unidentified fish, turtle (Testudines), even-toed ungulate (Artiodacytl), and white-tailed deer (*Odocoileus virginianus*). Early Woodland assemblages have wolf/coyote/dog (Canis) and elk (*Cervus canandensis*); these two mammal taxa have habitat in oak openings, oak/deciduous forests, and prairies. Middle Woodland assemblages have the following taxa that are not in the Early Woodland assemblage: striped skunk (*Mephitis mephitis*), muskrat (*Ondatra zibethicus*), and raccoon (*Procyon lotor*). These species have habitat in oak/deciduous forest, oak openings, and aquatic/wetlands. Based on the taxa and habitat data, there appears to be very minor increase in the use of aquatic/wetland habitat use during the Middle Woodland component.

Relative frequency by taxa are calculated using two different techniques to compare the Early and Middle Woodland zooarchaeological assemblages. One method addresses overall composition within a component by examining the frequency of bird, fish, mammal, and reptile taxa within each component. The second technique compares the relative frequency of a particular taxa across the component to identify changes in taxa frequency through time.

Taxa represented in the Early Woodland and Middle Woodland assemblages include bird, fish, mammal, and reptiles (Table 6.38). Both assemblages are characterized by high relative frequencies of mammal remains and very low to low quantities of bird, fish, and reptile remains (Table 6.38; Figure 6.8; Figure 6.9). Based on NISP, mammal remains have a slightly higher relative frequency, totaling 96.38 percent in the Middle Woodland assemblage as compared to the Early Woodland study assemblage where they compose 89.94 percent (Figure 6.8). Reptiles, fish, and birds exhibit higher relative frequencies in the Early Woodland assemblage as compared to the Middle Woodland assemblage.

Relative frequency by bone weight indicates similar patterning within the Early Woodland and Middle Woodland study assemblages (Figure 6.9). Both assemblages are dominated by mammal bone which represents 97.79 percent of the Early Woodland assemblage, by bone weight, and 99.48 percent of the Middle Woodland assemblage. Mammal bone has a slightly higher abundance in the Middle Woodland assemblage as compared to the Early Woodland. Birds, fish, and reptiles have slightly higher relative frequencies in the Early Woodland assemblage as compared to the Middle Woodland assemblage.

The NISP and bone weight data reflect the higher abundance of mammal remains in the Middle Woodland assemblage and suggest a modest increase in importance. With the increase of mammal exploitation in the Middle Woodland, there is a modest decrease in the abundance of bird, fish, and reptile remains.

Table 6.38. Relative Frequencies of Taxa based on NISP and Bone Weight for the Early Woodland and Middle Woodland Zooarchaeological Assemblages

Taxa	NISP		Bone Weight	
	Early Woodland (n=729)	Middle Woodland (n=1244)	Early Woodland (236.83 g)	Middle Woodland (588.14) g
Bird	0.28	0.16	0.29	0.05
Fish	5.10	2.33	0.37	0.10
Mammal	89.94	96.38	97.79	99.48
Reptile	4.67	1.13	1.55	0.37
Total	100.00	100.00	100.00	100.00

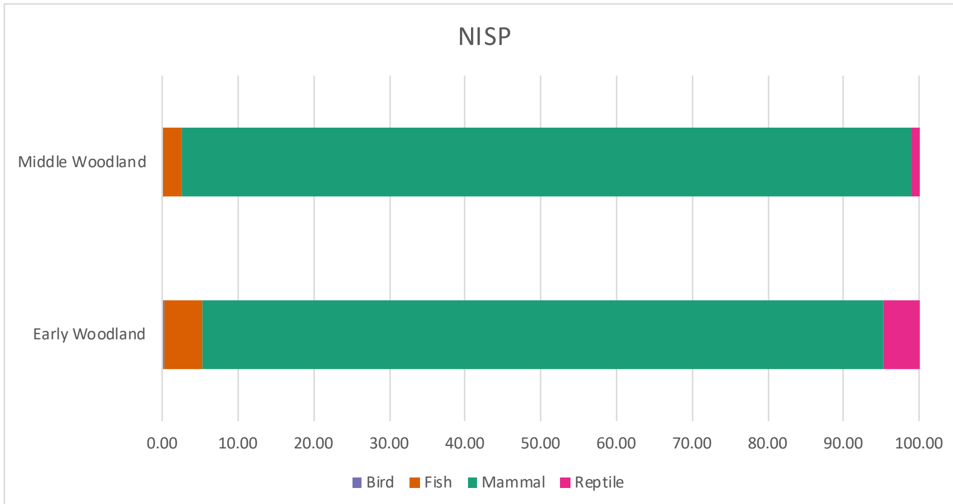


Figure 6.8. Relative frequency of animal taxa based on NISP for the Early Woodland and Middle Woodland zooarchaeological assemblages.

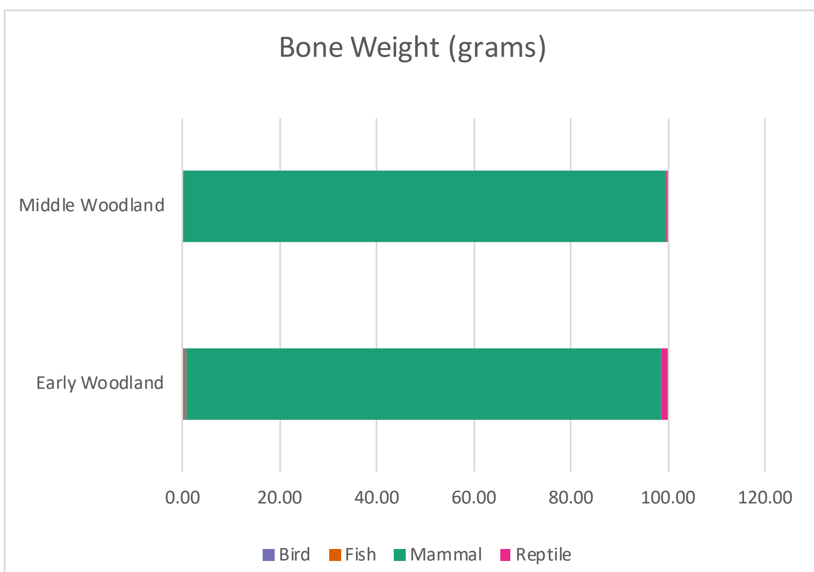


Figure 6.9. Relative frequency of animal taxa based on bone weight (grams) for the Early Woodland and Middle Woodland zooarchaeological assemblages.

Comparing the abundance of the taxa that is present in both the Early Woodland and Middle Woodland assemblage is further accomplished through identification of relative frequencies of individual taxa based on NISP and bone weight (Figure 6.10; Figure 6.11). Frequencies are calculated for each taxon by component to identify changes in taxon frequency. Based on NISP, an equal number of bird fragments were recovered from the Early and Middle Woodland component. Higher frequencies of fish and reptile remains were recovered from the Early Woodland component as compared to the Middle Woodland component. The Middle Woodland component yielded more mammal remains.

Using bone weight, higher frequencies of birds, fish, and reptiles were recovered from the Early Woodland component than the Middle Woodland component (Figure 6.11). The Middle Woodland component yielded more mammal remains.

Zooarchaeological abundance measures are limited to the mammal taxon given the relatively low amounts of identified bird, fish, and reptile remains from the Early and Middle Woodland assemblages. Mammal remains from feature contexts are compared in order to somewhat control for sample sizes. Mammals were recovered from eight Early Woodland and eight Middle Woodland features. The pattern of mammal abundance is illustrated with boxplots that display and compare the frequency distribution of mammal remains by count and by weight (Figure 6.12; Figure 6.13).

The box plots indicate similar ranges for the mammal remains from the Early and Middle Woodland features. The Early Woodland features tend to have lower values, based on both counts and weights, for the mammal remains than the Middle Woodland features. The Middle Woodland data indicate a higher median for mammal count and weight. However, the notches of the boxplot, overlap indicating that the data are not significantly different at the 0.05 confidence level. As such, the counts and weights of mammal remains do not indicate any statistical difference in mammal abundance between the Early and Middle Woodland feature assemblage.

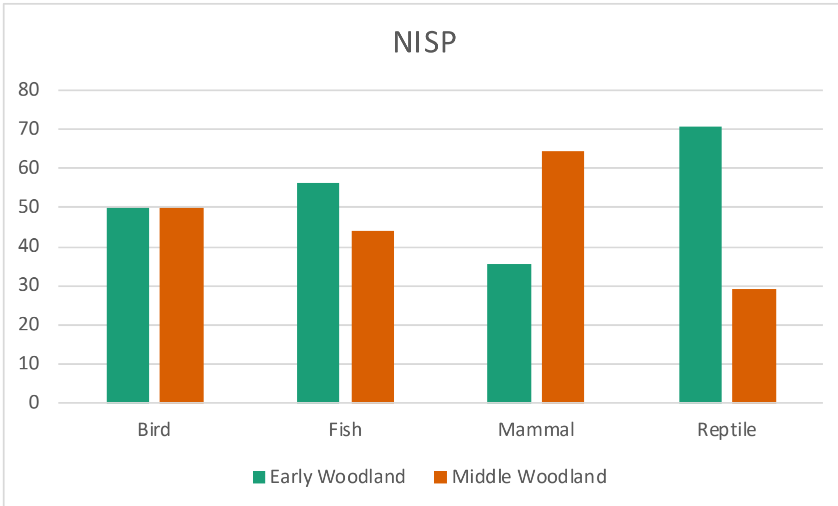


Figure 6.10. Relative frequencies of animal taxa across the Early and Middle Woodland components and based on NISP using the Early Woodland and Middle Woodland zooarchaeological assemblages

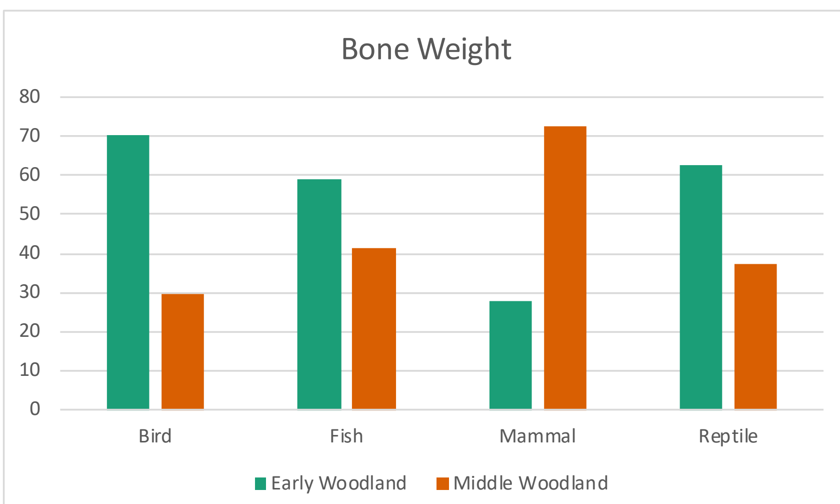


Figure 6.11. Relative frequencies of animal taxa across the Early and Middle Woodland components and based on bone weight using the Early Woodland and Middle Woodland zooarchaeological assemblages

Ubiquity values for bird, fish, mammals, and reptiles are compared for the Early Woodland and Middle Woodland zooarchaeological assemblages (Table 6.39; Table 6.40). Examining all contexts (features and units), birds and fish have a higher ubiquity in Middle Woodland assemblages than in the Early Woodland assemblage. Mammals and reptiles have a higher ubiquity in Early Woodland assemblages than in the Middle Woodland assemblages.

The top five ubiquity values for Early Woodland animal taxa are mammal (unidentified), turtle (Testudines), white-tailed deer (*Odocoileus virginianus*), fish (unidentified), and even-toed ungualte (Artiodactyl). The top five ubiquity values for Middle Woodland animal taxa are mammal (unidentified), white-tailed deer (*Odocoileus virginianus*), turtle (Testudines), fish (unidentified), and bird (unidentified). The top four most ubiquitous taxa are the same for both Early Woodland and Middle Woodland: mammals (unidentified), turtle (Testudines), white-tailed deer (*Odocoileus virginianus),* and fish (unidentified).

Discussion

The Early Woodland and Middle Woodland assemblages are similar in terms of overall plant and animal composition. Both are characterized as having high frequencies of wood charcoal, moderate to high amounts of nutshell, and low frequencies of squash rind and wild seed taxa. Domesticates, consisting of squash (*Curcurbita* sp.) rind are present in both assemblage; the Middle Woodland assemblage also has tobacco (*Nicotiania* sp.). Animal taxa in in the Early and Middle Woodland assemblages consist of very high quantities of mammal remains with low representation of bird, fish, and reptiles.

Taxa represented in the Early Woodland assemblage includes four plant and five animal species/types. The plant taxa consist of two nutshell taxa (black walnut and acorn), squash rind, and a single wild nightshade family (Solanaceae) seed that likely represents incidental inclusion. The identified animal species are wolf/coyote/dog (Canis), elk (*Cervus canadensis*), even-toed ungulate

Figure 6.12. Boxplots comparing relative abundance of mammal remains by count in Early Woodland and Middle Woodland features. Values are counts re-expressed as natural logarithm (ln[*c*]). Samples include eight Early Woodland features and eight Middle Woodland features. Raw data is provided as Appendix M.

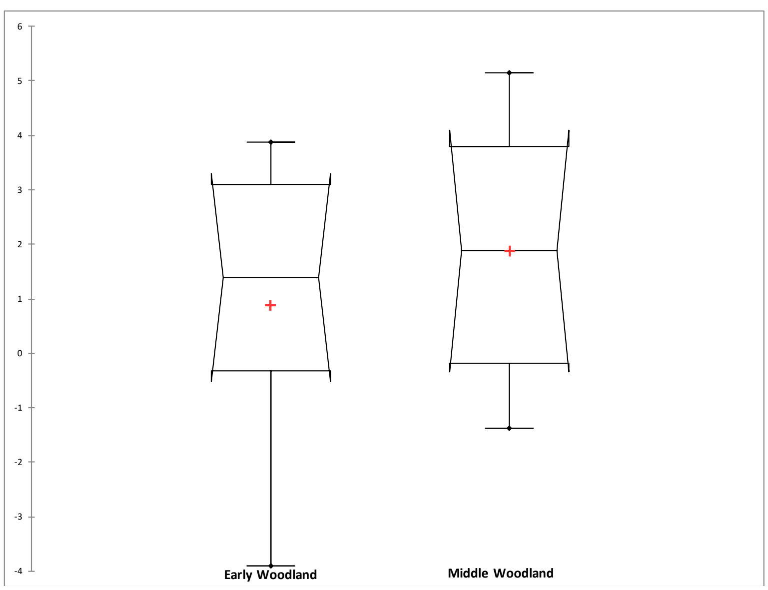


Figure 6.13. Boxplots comparing relative abundance of mammal remains by weight in Early Woodland and Middle Woodland features. Values are weights re-expressed as natural logarithm (ln[*w*]). Samples include eight Early Woodland features and eight Middle Woodland features. Raw data is provided as Appendix M.

(Artiodactyl), white-tailed deer (*Odocoileus virginianus*), and turtle (Testudines). Unidentified bird and fish remains are also present in the Early Woodland assemblage.

Taxa represented in the Middle Woodland assemblage consist of nine plant and eight animal species/types. The plant taxa consist of four nutshell types (hickory, acorn, bitternut hickory, and hazelnut), squash rind, and three wild seed types (spurge, bedstraw, knotweed) and tobacco. The spurge, bedstraw, and knotweed likely represent incidental inclusions in the assemblage; the association of tobacco with the Middle Woodland component is provisional. The identified animal species are channel catfish (*Ictalurus punctatus*), even-toed ungulate (Artiodactyl), skunk (*Mephitis*

Table 6.39. Ubiquity Values by Animal Taxa for the Early Woodland and Middle Woodland Zooarchaeological Assemblages

Taxon	Early Woodland	Middle Woodland
Bird	0.019	0.029
Fish	0.056	0.074
Mammal	0.593	0.441
Reptile	0.185	0.103

Table 6.40. Ranking of the top Five Ubiquity Values for the Early Woodland and Middle Woodland Zooarchaeological Assemblages

Early Woodland				Middle Woodland			
Rank	Taxon	Species	Ubiquity	Rank	Taxon	Species	Ubiquity
1	Mammal	Unidentified	0.574	1	Mammal	Unidentified	0.426
2	Reptile	Testudines	0.185	2	Mammal	*Odocoileus virginianus*	0.103
3	Mammal	*Odocoileus virginanus*	0.111	3	Reptile	Testudines	0.103
4	Fish	Unidentified	0.056	4	Fish	Unidentified	0.074
5	Mammal	Artiodactyl	0.037	5	Bird	Unidentified	0.029

mephitis), muskrat (*Ondatra zibethicus*), raccoon (*Procyon lotor*), white-tailed deer *(Odocoileus virginianus*), and turtle (Testudines). Unidentified bird remains are also present in the assemblage.

Plant and animal species common to the Early and Middle Woodland components include walnut family (Juglandaceae) nutshell, acorn (*Quercus* sp.) nutshell, squash rind (*Curcurbit* sp.), white-tailed deer (*Odocoileus virginianus*), even-toed ungulate (Artiodactyle), and turtle (Testudines). The Early and Middle Woodland assemblages also included unidentified fish and bird species.

Several plant and animal species are unique to the Early and Middle Woodland components. The Early Woodland component yielded black walnut (*Junglas nigra*), wolf/coyote/dog (Canis), and elk (*Cervus canadensis*) that were not identified as part the Middle Woodland assemblage. Represented in the Middle Woodland assemblage but not in the Early Woodland assemblage are hickory nutshell (*Carya* sp.), hazelnut (*Corylus* sp.), bitternut hickory (*Carya cordiformis*) channel catfish (*Ictalurus punctatus*), and skunk (*Mephitis mephitis*), muskrat (*Ondatra zibethicus*), raccoon (*Procyon lotor*), as well as a few wild seed varieties.

The plant food ratio (*q*) for nutshell, squash rind, and wild seeds indicates that nuts are the major plant food constituent for both the Early and Middle Woodland components. The higher plant food ratio (*q*) of nutshell represented in the Middle Woodland assemblage suggests that nuts contributed slightly more to the overall diet in the Middle Woodland as compared to the Early Woodland assemblage. Squash rind and wild seeds contribute much less to the overall plant food assemblage for both the Early and Middle Woodland assemblage. However, based on the plant food ratio, these plant types may be more slightly important in the Middle Woodland component compared to the Early Woodland component.

Abundance analysis of plant foods is limited to the nutshell as too few wild seeds and squash rind were recovered to allow for meaningful comparison. Examining all nutshell derived from feature contexts associated with the Early and Middle Woodland components indicates that there is no statistically significant difference in nutshell abundance between these occupations. Nutshell, squash rind, and wild seeds are more ubiquitous during the Middle Woodland component as compared to the Early Woodland suggestive of more prevalent use.

Three of the plant taxa occur in the top five ranked most ubiquitous taxa are the same for both Early and Middle Woodland assemblage. These three taxa are walnut family (Juglandaceae) nutshell, squash (*Cucurbita* sp.) rind, and acorn (*Quercus* sp.) nutshell.

Examining the zooarchaeological data, the taxa composition of the Early and Middle Woodland components are nearly identical. Both are characterized, using NISP and bone weight, as having very high frequencies of mammal remains with low to very low frequencies of bird, fish, and mammal remains. Based on counts and weights of mammal derived from feature contexts, there are no significant differences in mammal abundance between the Early and Middle Woodland occupations. Based on particular taxon frequencies measured across the components, all mammals (especially white-tailed deer) have higher frequencies in Middle Woodland contexts than Early Woodland contexts. All fish and reptiles (turtle) have higher frequencies in the Early Woodland assemblage as compared to the Middle Woodland assemblage.

Based on ubiquity, examining the taxa types (mammal, fish, bird, reptile), birds and fish are more ubiquitous in the Middle Woodland as compared to the Early Woodland component. Mammals and reptiles are more ubiquitous in the Early Woodland than Middle Woodland. Four of the animal taxa occur in the top five ranked most ubiquitous taxa are the same for Early and Middle Woodland components.

In sum, the ingredients used by both the Early and Middle Woodland site occupants included heavy use of nuts and medium/large mammals, especially white-tailed deer. Nuts were important for both components but may have been slightly more so in the Middle Woodland component. Domesticates, consisting of squash (*Cucurbita* sp.) rind, are associated with both components; tobacco (*Nicotiania* sp.) is also present within the Middle Woodland assemblage.

The ingredients associated with the Early Woodland component, based on taxonomic representation and quantification measures, are nuts (black walnut, acorn, and walnut family), squash rind, medium/large mammals (mostly white-tailed deer and even-toed ungulate), and turtle.

The ingredients associated with the Middle Woodland component are nuts (hickory, acorn, hazelnut, and walnut family), squash rind, medium/large mammals (mostly white-tailed deer and even-toed ungulate), and turtle.

The most abundant and ubiquitous animal taxa are the same for the Early and Middle Woodland components, consisting of medium/large mammals, white-tailed deer, even-toed ungulate, and turtle. The most abundant and ubiquitous plant taxa for the Early and Middle Woodland is nutshell; however, different varieties of nuts are represented within each component.

Diversity and Taxonomic Representation

Differences in diversity between the Early and Middle Woodland assemblages are evaluated through the measuring of richness and equitability (evenness). Richness (S), equitability (V'), and the Shannon-Weaver index (H') are calculated separately for the plant and animal taxa represented in the Early Woodland and Middle Woodland assemblages (Table 6.41). Richness, for both the plant and animal data, indicate a slight increase in the number of taxa between the Early Woodland component compared to the Middle Woodland.

The evenness (V') values range from 0 to 1 with a value of 1 indicating an even distribution of taxa and lower values a less even distribution (Reitz and Wing 2008). Collectively, the evenness values for the plant macroremian and zooarchaeological assemblages from both the Early Woodland and Middle Woodland components suggest a trend towards a more even distribution. Although the equitability value (V') for the Early Woodland and Middle Woodland plant and animal assemblages are fairly close, the animal and plant taxa exhibit differential patterning. The plant taxa are more evenly distributed in the Middle Woodland assemblages than in the Early Woodland assemblages. For the animal taxa, the Early Woodland assemblages have a higher V'

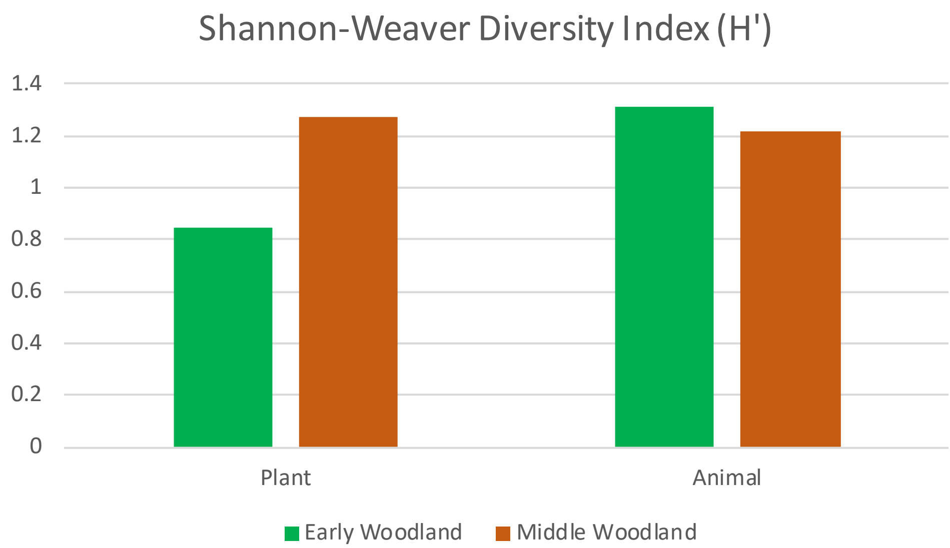


Figure 6.14. Shannon-Weaver Index for the Early Woodland and Middle Woodland plant macroremain and zooarchaeological assemblages.

Table 6.41. Diversity Values for the Early Woodland and Middle Woodland Plant Macroremain and Zooarchaeological Assemblages

Description of Measure		Plant Macroremains		Zooarchaeological Remains	
		Early Woodland	Middle Woodland	Early Woodland	Middle Woodland
S	Richness (number of taxa)	4	9	7	8
H’	Shannon-Weaver Diversity Index	0.847	1.272	1.309	1.218
V’	Equitability	0.611	0.578	0.673	0.586

value, and thus a more even distribution, as compared to the Middle Woodland assemblage.

The Shannon-Weaver diversity index (H') is calculated separately for the plant and animal taxa (Table 6.41; Figure 6.14). The plant data indicate that the Middle Woodland assemblages have a higher species diversity than the Early Woodland assemblages. The animal data indicate similar species diversity within the Early and Middle Woodland assemblage. The Early Woodland values, relative to animal taxa, are only very slightly higher than those for the Middle Woodland assemblage.

The diversity measurements indicate that, relative to the Early Woodland assemblages, Middle Woodland plant and animal assemblages are richer and plant taxa exhibit more species diversity. Animal species diversity is relatively similar for the Early Woodland and Middle Woodland assemblages, with Early Woodland values just slightly higher than those values for the Middle Woodland. The plant and animal taxa in both the Early and Middle Woodland assemblages trend towards more even distributions. The Middle Woodland plant taxa are slightly more even than the Early Woodland plant assemblages. The Middle Woodland animal taxa are slightly less even as compared to the Early Woodland animal assemblages.

Cooking and Processing Activities

Food processing is assessed through three aspects of the plant macroremains and faunal assemblage evaluating: (1) intensity and frequency of activities involving fire; (2) butchery practices; and (3) evidence for roasting, bone marrow extraction, and bone grease rendering. These three aspects are assessed broadly, using the site-wide patterning, as well as more specifically examining the cooking pit data.

Intensity and Frequency of Burning Activities

Plant macroremains and the zooarchaeological assemblages were examined across all contexts at the site for evidence of the intensity and frequency of burning activities associated with the Early and Middle Woodland components. The density and ubiquity of wood charcoal, and the relative frequencies of burned and unburned bone in the zooarchaeological assemblages, evaluate the intensity of activities involving fire for the Early Woodland and Middle Woodland components.

The presence of wood charcoal at archaeological sites has several possible sources including: wood collected and burned as fuel; tool use; wood that was discarded and burned; wood used in construction and later dismantled and burned; and wood charred as the result of site-wide conflagration (Pearsall 1988:100). At Finch, there is no evidence for site-wide fire, such as in situ burned posts and blanketing ash, or substantive use of wood for structural architecture. The archaeological evidence from Finch suggests that most burning occurred in controlled fires of hearths, cooking pits, and trash deposits and thus represents spent fuel (Miller 1988). As such, the wood charcoal can be used to assess intensity and frequency of activities involving fire, including tasks involving food processing.

Density and ubiquity measures both indicate greater intensity and frequency of wood use, and/or activities involving fire, during the Middle Woodland component as compared to the Early Woodland component. Using the plant macroremain data derived from the flotation samples, wood charcoal densities (*d*), counts or weight per 10 liters of flotation matrix, are calculated for the Early Woodland and Middle Woodland feature assemblages. The count densities indicate the much higher abundance of wood charcoal for the Middle Woodland assemblage, averaging over 18 fragments of wood charcoal per 10 liters, as compared to the Early Woodland assemblage, averaging just under two fragments per 10 liters. The density based on weights exhibits a similar pattern with more wood charcoal per 10 liter sample in the Middle Woodland assemblage as compared with the Early Woodland samples.

Ubiquity measures indicate that wood charcoal occurs in more Middle Woodland features as compared to Early Woodland features. Wood charcoal is present in 81 percent of the Middle Woodland features and 53 percent (just over half) of the Early Woodland features (Table 6.23).

The pattern of wood charcoal abundance is illustrated with a boxplot that displays and compares the frequency distribution for wood charcoal (Figure 6.15). Only the wood charcoal recovered from flotation are included in the box plot. The boxplot shown in Figure 6.15 includes those features where wood weight was greater than zero. For the Early Woodland contexts, six features are included and for the Middle Woodland contexts, 15 features are including in the analysis.

The box plot indicates a larger range for the standardized wood weight in the Middle Woodland samples as compared to the Early Woodland features. The Early Woodland data has one outlier, Feature 81, identified for the data set. Feature 81 is a large cooking pit that yielded a single wood charcoal fragment within an 80-liter sample. The medians for the Early and Middle Woodland components are similar and the notches overlap. As such, the standardized wood charcoal weights do not indicate any statistically significant differences in abundance between the Early and Middle Woodland features.

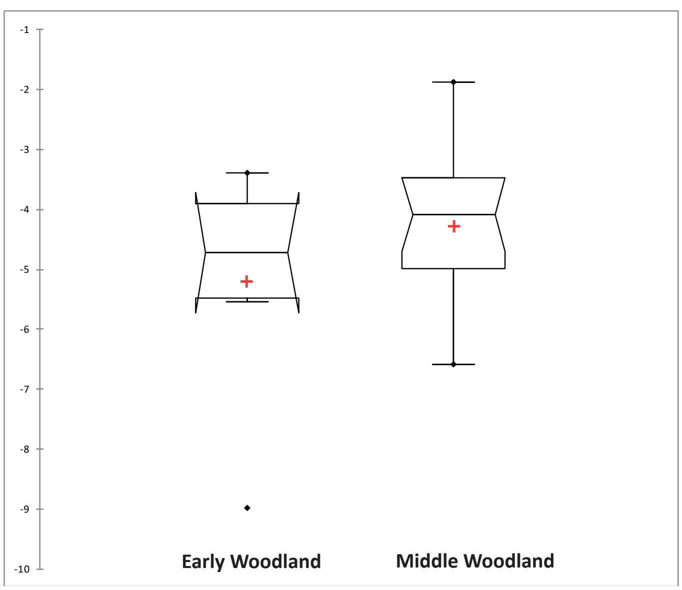


Figure 6.15. Boxplots comparing the relative abundance of wood charcoal in the Early and Middle Woodland contexts. Values are standardized weights re-expressed as natural logarithms. Sample sizes are: Early Woodland n=6, Middle Woodland n=15. Data is included as Appendix N.

Table 6.42. Relative Frequency of Burned Bone in the Early and Middle Woodland Zooarchaeolgoical Assemblages

Description	Count	Weight (g)	Percent Count	Percent Weight
Early Woodland Burned Bone	2456	312.66	59.96	69.10
Middle Woodland Burned Bone	2792	139.84	60.70	47.27

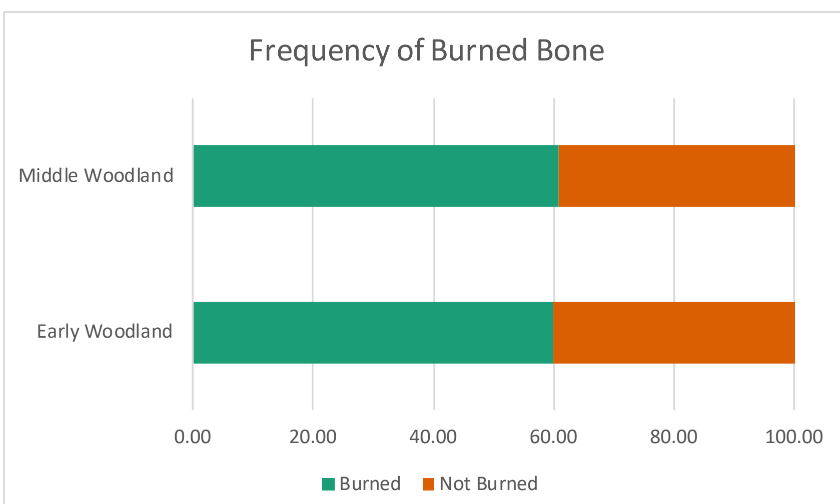


Figure 6.16. Frequency of burned bone for the Early Woodland and Middle Woodland zooarchaeological assemblages based on counts.

The identification and quantification of burned bone is used to investigate food processing activities as it is expected that at least some portion of the burned assemblage relates to cooking and food processing activities (Stiner et al. 1995:225). The Early and Middle Woodland zooarchaeological assemblage both exhibit similar high frequencies of burned bone (Figure 6.16; Table 6.42). The Early Woodland assemblage includes 4,096 fragments, weighing 452.5 g, that show cultural modification in the form of burning (Table 6.42). The number of burned specimens represents 59.96 percent (by count) and 69.10 percent (by weight) of the total assemblage. The Middle Woodland zooarchaeological assemblages also exhibits high frequencies of burned bone (Table 6.42). Fully 2792 fragments, weighing 377.65 g, show cultural modification in the form of burning. The number of burned specimens represents 60.70 percent (by count) and 47.27 percent (by weight) of the total assemblage.

The Early Woodland and Middle Woodland burned bone assemblages are examined for an evaluation of burning intensity based on the relative frequencies of burned bone color. Nearly all of the single color burned bone of both the Early Woodland and Middle Woodland assemblages are categorized as “4” denoting white (10YR9/0), fully calcined bone.

Within the Early Woodland zooarchaeological assemblage, nearly all of the single color burned bone, by both count and weight, are burned to 4 on the ordinal scale, indicating full calcination (Table 6.43; Table 6.44). Calcined bone accounts for 98.83 percent by count and 99.51 percent by weight of the single color burned bone fragments. The relative frequency of colors observed on bone fragments exhibiting multiple colors indicates that white, blue, and no change are the most frequently observed colors respectively representing 37.3 percent, 25.46 percent, and 31.50 percent. As with the bone fragments of a single color, there appears to be high frequencies of bone that was subjected to very high heat (in excess of 600 degrees) resulting in full calcination.

The Middle Woodland zooarchaeological assemblage also has high frequencies of bone burned to 4 on the ordinal scale, indicating full calcination (Table 6.44). Calcined bone accounts for 98.66 percent by count and 99.28 percent by weight of the single color burned bone fragments.

Table 6.43. Relative Frequency of Single Color Burned Bone Ordinal Ranking for the Early and Middle Woodland Zooarchaeological Assemblages

Color		Early Woodland		Middle Woodland	
Color Code	Munsell Color	Percent Count	Percent Weight	Percent Count	Percent Weight
1	black (5YR2/1)	0.86	0.08	0.52	0.08
2	gray (5YR6/1)	--	--	--	--
3	blue (5BS5/10)	0.31	0.41	0.82	0.63
4	white (10Y9/0)	98.83	99.51	98.66	99.28

Table 6.44. Relative Frequency of Multiple Color Burned Bone Ordinal Ranking for the Early and Middle Woodland Zooarchaeological Assemblage

Color		Early Woodland		Middle Woodland	
Color Code	Munsell Color	Percent Count	Percent Weight	Percent Count	Percent Weight
0	no change	36.30	31.50	34.70	32.97
1	black (5YR2/1)	2.67	2.78	7.47	8.23
2	gray (5YR6/1)	1.85	2.78	1.53	0.98
3	blue (5BS5/10)	24.81	25.46	22.44	22.12
4	white (10Y9/0)	34.07	37.30	33.83	35.58

Note: The table provides the count of the number of observation of a particular color and there may be more than one color on a bone fragment.

The relative frequency of colors observed on bone fragments exhibiting multiple colors indicates that white, blue, and no change are the most frequently observed colors respectively representing 33.83 percent, 22.12 percent, and 32.97 percent. As with the bone fragments of a single color, there appears to be high frequencies of bone that was subjected to very high heat (in excess of 600 degrees) resulting in full calcination.

Butchery Practices

Cut marked bone is present in both the Early Woodland and Middle Woodland assemblages (Table 6.45, Table 6.46). The cut marked bone exhibits evidence for stone tool use based on the cut shape cross section and analysis and cut mark grouping location (Stencil 2015:114).

Cut marked bone is present in the Early Woodland zooarchaeological assemblage, evident on five specimens weighing a total 16.41 grams (Table 6.45). All cut marked bone represents mammal and is identified as *Odocoileus virginianus* (white-tailed deer) and medium/large mammal. The white-tailed deer with cut marks include a metacarpal fragment and astragalus fragments derived from cooking pits (features 81 and 581). The medium/large mammal remains with cut marks were recovered adjacent to Feature 83.

The Middle Woodland zooarchaeological assemblage includes eight specimens exhibiting cut marks, weighing 19.13 g, all identified as medium/large or large mammal (Table 6.46). One specimen is identified as the calcaneus of an Odocoileus virginianus (white-tailed deer). Although species is not identifiable on the other specimens, three specimens represent long bone fragments. The large mammal specimens were recovered from a cooking pit (Feature 129). The medium/large fragments were present in unit contexts (Units 172 and 192) and are not associated with a particular feature.

In both the Early Woodland and Middle Woodland assemblages, the cut marked bone represents medium/large and large mammals, with some fragments identified as white-tailed deer (*Odocoileus virginianus*). Except for two cut marked medium/large mammal specimens associated with the

Middle Woodland assemblage, all cut marked bone is derived from cooking pits. Of the cut marked bone identified to element, all represent the lower leg portion of the mammal.

The cut marked bone associated with the Early and Middle Woodland components at the Finch site conform to the patterning observed for the Early Woodland and Middle Woodland occupations at Cooper's Shores, Stonefield, Millville, and Highsmith (Lippold 1971). Represented white-tailed deer (*Odocoileus virginianus*) elements typically consisted of the fore and hind limb, as well as pieces of the cranium, teeth, and antler. Commonly, metarsals, metacarpals, and long bones were broken with only proximal and distal ends remaining intact. Lippold (1971) interprets this patterning as evidence for bone grease preparation and possibly for tool manufacture. The

Table 6.45. Cut Marked Bone in the Early Woodland Zooarchaeological Assemblage

Taxon	Size	Species	Common Name	Element	Count	Weight (g)	Provenience
Mammal	Large	*Odocoileus virginianus*	white-tailed deer	metacarpal	1	12.96	Feature 81
Mammal	Large	*Odocoileus virginianus*	white-tailed deer	astragalus	2	2.45	Feature 581
Mammal	M/L	--	--	--	2	1	Unit 203

Table 6.46. Cut Marked Bone in the Middle Woodland Zooarchaeological Assemblage

Taxon	Size	Species	Common Name	Element	Count	Weight (g)	Provenience
Mammal	Large	--	--	Indeterminate	3	3.33	Feature 129
Mammal	Large	--	--	Long bone	2	2.05	Feature 129
Mammal	Large	*Odocoileus virginianus*	white-tailed deer	Calcaneus	1	12.92	Feature 129
Mammal	M/L	--	--	Indeterminate	1	0.43	Unit 172
Mammal	M/L	--	--	Long bone	1	0.4	Unit 197

appendicular skeleton yields white grease, richer in oleic acid than the yellow grease derived from the axial skeleton (Binford 1978; Prince 2007). Moreover, the cancellous bones of the appendicular skeleton contain the richest and most abundant white fat reserves (Binford 1978; Church and Lyman 2003).

As described above, the Early and Middle Woodland zooarchaeological assemblages are characterized by high frequencies of burned bone. Within the burned bone assemblage, bone burned to a single color and bone burned to multiple colors indicates the type of processing activities involving bone grease production, marrow extraction, and roasting. The burned bone Early Woodland and Middle Woodland assemblages include both single color and multiple color burned bone (Table 6.47). Within the Early Woodland burned faunal assemblage, based on counts, single color burned bone represents 52.12 percent and multiple color burned bone totals 47.88 percent (Table 6.47). Using weights, multiple color burned bone is more prevalent, representing 58.00 percent, with single color burned bone totaling 42 percent. These data suggest that bone grease production, marrow extraction, and roasting are all largely equally represented activities at the site for the Early Woodland component.

Evidence for Roasting, Bone Marrow Extraction, and Bone Grease Rendering

As detailed above, and summarized in Table 6.1, evidence for specific animal processing tasks are gleaned from the zooarchaeological assemblage through burned bone patterning (single or mutliple burn colored bone) and fragmentation ratios.

Burned bone in the Early and Middle Woodland assembles include both single and multiple color burned bone (Table 6.47). The Early Woodland assemblage, based on counts, has slightly more single colored burned bone than multiple color burned bone. By weights, the pattern is reversed with higher relative frequencies of multiple colored bone than single color burned bone.

The Middle Woodland burned bone assemblage includes single color and multiple color burned bone (Table 6.47). Using counts, there is slightly more multiple colored burned bone, fully 51.72

percent, than single color burned bone, totaling 48.28 percent. By weight, multiple colored bone represents 68.62 percent and single color bone represents 31.38 percent.

The bone fragmentation ratio (*g*) addresses food processing activities (marrow extraction and/or bone grease production) and overall intensity (Stencil 2015). Overall, the Early Woodland assemblage exhibits lower overall fragmentation, as indicated by the higher fragmentation ratio value, as compared to the Middle Woodland assemblage (Table 6.48; Figure 6.17). This patterning, the higher fragmentation values for the Early Woodland assemblages and lower values for the Middle Woodland assemblages, holds constant for all recovery techniques and proveniences (unit or feature). Within feature contexts, there is a marked difference in the fragmentation ratio between the Early Woodland and Middle Woodland assemblages suggesting representation of differential activities.

Table 6.47. Relative Frequency of Single and Multiple Burning Types for the Early and Middle Woodland Zooarchaeological Assemblages

	Early Woodland		Middle Woodland	
Description	Percent Count	Percent Weight	Percent Count	Percent Weight
Single Color	52.12	42.00	48.28	31.38
Multiple Color	47.88	58.00	51.72	68.62

Table 6.48. Fragmentation Ratios by Recovery Technique and Provenience for the Early Woodland and Middle Woodland Zooarchaeological Assemblages

Provenience and Recovery Technique	Early Woodland			Middle Woodland		
	NISP	Weight (g)	Fragmentation Ratio (g)	NISP	Weight (g)	Fragmentation Ratio (g)
Feature						
Dry Screen	248	98.84	0.40	507	306.06	0.60
Water Screen	180	16.27	0.09	130	21.46	0.17
Flotation	21	3.35	0.16	35	8.27	0.24
Subtotal	449	118.46	0.26	672	335.79	0.50
Unit						
Dry Screen	257	117.4	0.46	551	247.68	0.45
Water Screen	20	0.88	0.04	21	4.67	0.22
Flotation	3	0.09	0.03	0	0	
Subtotal	280	118.37	0.42	572	252.35	0.44
Total (Feature & Unit)	729	236.83	0.32	1244	588.14	0.47

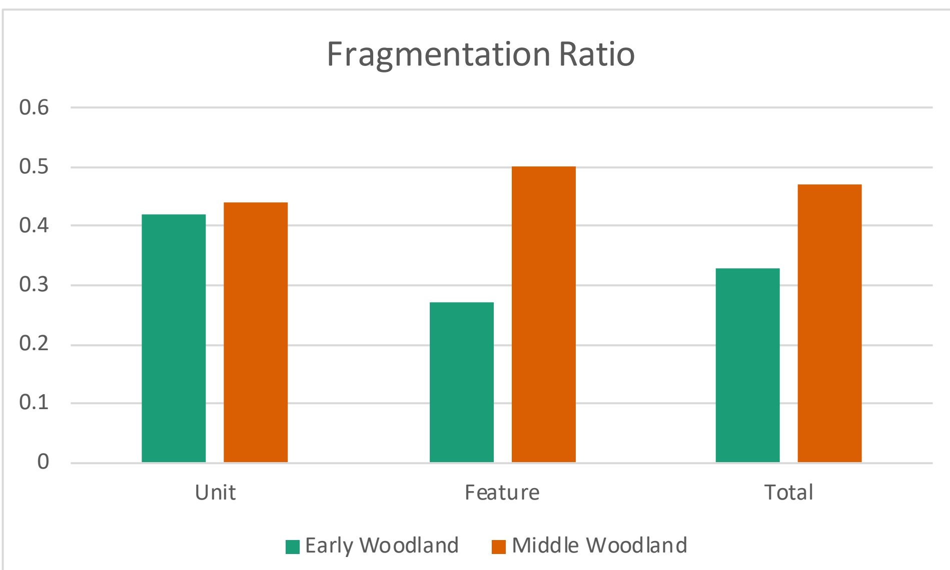


Figure 6.17. Fragmentation ratios (g) for the Early Woodland Middle Woodland zooarchaeological assemblages by provenience.

The animal processing model evaluates evidence of roasting, bone marrow extraction, and/or bone grease rendering based on fragmentation ratios and relative frequencies of single versus multiple colored burned bone. The site-wide Early Woodland and Middle Woodland data indicate higher relative frequencies of multiple colored burned bone as compared to bone burned to a single color. Multiple colored burned bone in the Middle Woodland assemblage has a higher relative frequency as compared to the Early Woodland component. The Middle Woodland assemblage has a higher fragmentation ratio as compared to the Early Woodland component. The relatively high frequency of multiple colored bone coupled with the higher fragmentation ratio suggests that more roasting activities are represented in the Middle Woodland component as compared to the Early Woodland.

The Early Woodland assemblage has higher frequencies of single colored bone (by count) but a lower fragmentation ratio, suggesting more intensive bone marrow extraction and bone grease rendering. The intensity of bone grease rendering for the Early Woodland component further suggests a winter occupation. Bone grease is a reliable source of fat when other are depleted. In northern climates, lean late winter or early spring animal will yield bone grease (Church and Lymon 2003; Prince 2007). Based on the lower relative frequency of multiple colored bone compared to the Middle Woodland, the roasting activities were less intensive in the Early Woodland component.

Cooking Pit Data

To further explore processing activities associated with the Early and Middle Woodland components, cooking pits are examined relative to burning frequency and intensity and evidence for specific animal processing tasks (marrow extraction, bone grease rendering, and roasting). A total of nine cooking pits are associated with the Early Woodland component (excludes Feature 681) and nine cooking pits are associated with the Middle Woodland component (Table 6.4; Table 6.6).

Table 6.49. Common and Taxonomic Names of Plants and Animals Identified in the Early Woodland and Middle Woodland Cooking Pits

Taxon	Common Name	Early Woodland	Middle Woodland
Plant Assemblage			
Wood Charcoal	--	x	x
Nuts			
Carya sp.	hickory		x
Corylus sp.	hazelnut		x
Carya cordiformis	bitternut hickory		x
Juglandaceae	walnut family	x	
Juglans nigra	black walnut	x	
Quercus sp.	acorn	x	x
Unidentified nutshell	--	x	x
Nutmeat	--		x
Seeds			
Solanaceae	nightshade (family)	x	
Cucurbits			
Cucurbita sp. Rind	squash rind	x	
Zooarchaeological Assemblage			
Bird			
Unidentified	--		x
Fish			
Ictalurus punctatus	channel catfish		x
Unidentified		x	x
Mammal			
Artiodactyl	even-toed ungulate		x
Canis	wolf/coyote/dog	x	
Odocoileus virginianus	white-tailed deer	x	x
Procyon lotor	raccoon		x
Unidentified	--	x	x
Reptile			
Testudines		x	x
Unidentified		x	x

Table 6.50. Composition and Relative Frequency of the Zooarchaeological Assemblages from the Early and Middle Woodland Cooking Pits

	Early Woodland				Middle Woodland			
Taxon	Count	Weight (g)	Percent Count	Percent Weight	Count	Weight (g)	Percent Count	Percent Weight
Bird	0	0			1	0.03	0.04	0.01
Fish	35	0.85	1.50	0.63	29	0.61	1.02	0.15
Mammal	303	78.32	12.94	57.70	630	332.99	22.18	84.11
Reptile	25	1.5	1.07	1.11	3	0.43	0.11	0.11
Unidentified	1978	55.07	84.49	40.57	2177	61.83	76.65	15.62
Total	2341	135.74	100.00	100.00	2840	395.89	100.00	100.00

Both the Early and Middle Woodland cooking pits contained wood charcoal, plant foods, and animal remains (Table 6.49, Table 6.50). In the Early Woodland cooking pits, plant foods are represented by nuts (walnut family, black walnut, and acorn), squash rind, and a single wild seed. Identified animal taxa includes fish (all unidentified), white-tailed deer (*Odocoileus virginianus*), wolf/coyote/dog (Canis), turtle (Testudines), unidentified mammal reamains, and specimens unidentfiable to species.

Plant foods in the Middle Woodland cooking pits are limited to nuts. Hickory (*Carya* sp.), hazelnut (*Corylus* sp.), acorn (*Quercus* sp.), bitternut hickory (*Carya cordiformis*), nutmeats, and unidentfied varieties are represented in the assemblage. Identified animal taxa consist of bird (unidentified), channel catfish (*Ictalurus punctatus*) and unidentified fish, even-toed ungulate (Artiodactyl), white-tailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*), unidentified mammal remains, and specimens unidentifiable to species.

The comparative intensity of burning activities associated with the cooking pits are evaluated for the Early and Middle Woodland components using relative frequencies of wood charcoal, burned bone, and burned bone color. Wood charcoal density is calculated using the wood recovered from the cooking pit flotation samples (Table 6.51). The Middle Woodland cooking pits yielded a higher density of wood charcoal, by both count and weight, as compared to the Early Woodland cooking pits. By count, Middle Woodland pits averaged 8.14 fragments per ten liters of matrix and Early Woodland pits yielded 3.07 fragments per ten liters. Using weights, Middle Woodland cooking pits have a slightly higher density of 0.07 g per ten liters than the Early Woodland wood charcoal density at 0.03 g per ten liters. Of note, the Early and Middle Woodland cooking pits exhibit wood charcoal densities that are lower than the site wide average (Table 6.51).

The relative frequencies of burned bone from the Early and Middle Woodland cooking pits are used to further evaluate intensity of burning activities associated with food processing (Table 6.52). Based on counts, the Early Woodland cooking pits have higher frequencies of unburned bone (60.53 percent) than burned bone (39.47 percent). The Middle Woodland cooking pits have slightly higher frequencies of unburned bone (53.24 percent) than burned bone (46.76 percent). Using weights, the pattern remains the same with higher frequencies of unburned bone than burned bone in both the Early and Middle Woodland cooking pit assemblage. Notably, based on weights, the Middle Woodland cooking pits have a very high frequency (76.77 percent) of unburned bone relative to burned (23.23 percent).

Examining the relative frequencies of the burned bone assemblage from the Early and Middle Woodland cooking pits reveals little difference in the burning type represented in the assemblage (Table 6.53). Based on counts, the burned bone of both assemblages consist of slightly elevated frequencies of bone burned to a single color than bone that is burned to multiple colors. Using bone

Table 6.51. Wood Charcoal Density of the Early Woodland and Middle Woodland Cooking Pits

Component	Count	Weight (g)	Liters	Density (*d*) (count)	Density (*d*) (weight)
Early Woodland	31	0.32	101	3.07	0.03
Middle Woodland	48	0.411	59	8.14	0.07

Note: Table includes wood charcoal recovered from flotation samples. Density values are counts/weights per ten liters.

Table 6.52. Relative Frequency of Burned Bone from the Cooking Pits by Component

	Early Woodland		Middle Woodland	
Description	Count	Weight	Count	Weight
Burned	39.47	46.69	46.76	23.23
Not Burned	60.53	53.31	53.24	76.77

weight, both the Early and Middle Woodland assemblages have very high frequencies of bone burned to multiple colors than bone burned to a single color. Of the bone burned to a single color, the Early and Middle Woodland assemblages are almost exclusively fully calcined bone.

Fragmentation ratios (*g*) are calculated for all NISP across all contexts and for the cooking pits (Table 6.54). The fragmentation ratio for all NISP associated with the Early and Middle Woodland assemblages indicates an increase in the fragmentation ratio from the Early Woodland to the Middle Woodland. This suggests that the Middle Woodland NISP assemblage is not as fragmented as the Early Woodland assemblage. Middle Woodland activities likely included more bone marrow extraction and less intensive bone grease production than the Early Woodland occupation. The

Table 6.53. Relative Frequencies of Burned Bone Types in the Early and Middle Woodland Cooking Pit Assemblage.

	Percent - Count		Percent - Bone Weight	
	Early Woodland	Middle Woodland	Early Woodland	Middle Woodland
Single	54.11	53.31	26.87	24.12
Multiple	45.89	46.69	73.13	75.88
Total	100.00	100.00	100.00	100.00

Table 6.54. Fragmentation Ratios for the Early and Middle Woodland Zooarchaeological Assemblages

	Early Woodland			Middle Woodland		
	NISP	Weight	Ratio (*g*)	NISP	Weight	Ratio (*g*)
All Contexts	729	236.83	0.32	1244	588.14	0.47
Cooking Pits	363	80.67	0.22	663	334.06	0.50

pattern of higher fragmentation ratio holds when just the cooking pits are examined. The faunal remains in the Middle Woodland cooking pits yield a higher fragmentation ratio as compared to the Early Woodland.

Summary

This chapter presented the analysis of the plant macroremains and zooarchaeological remains associated with the Early and Middle Woodland components at the Finch site. The chapter reviewed the methods employed for the plant macroremain and zooarchaeological analyses, implementing qualitative and quantitative measures to identify ingredients associated with each component. The methods also included the development of an archaeological model to delineate specific cooking/processing activities based on patterning of wood charcoal and burned bone. The ecological setting reveals that the Finch site is situated within an area of large oak openings (or savanna) surrounded by zones of open water and marshlands as well as smaller zones of oak forests and prairie, an environmental context supportive of a wide variety of terrestrial, avian, and aquatic resources. Ethnohistoric sources indicate possible uses and ways of processing for nuts and squash, two types of the more common plant that have been identified within the Finch assemblage. Nut use and processing varies by type from hand picking of nutmeats for black walnut or hazelnut to more extensive processing requirements, involving boiling, stewing, or roasting/parching for hickory and/or acorn nuts.

The plant macroremain and zooarchaeological assemblages indicate that the ingredients used by both the Early and Middle Woodland site occupants included heavy use of nuts and medium/large mammals, especially white-tailed deer (Table 6.55). Nuts were important for both components, but may have been slightly more so for the Middle Woodland component. Although some nut types are common to both components, including acorn, walnut family, some nuts are unique to each component, reflecting distinct preferences. Black walnuts are only associated with the Early Woodland while hickory, hazelnut, and bitternut hickory occur with the Middle Woodland component. Domesticates are associated with both components; low amounts of squash rind are also present in both the Early and Middle Woodland assemblages. In addition to the heavy representation of white-tailed deer for both components, turtle, bird, and fish appear in both Early and Middle Woodland assemblage. Turtles are more common in the Early Woodland assemblage, while birds and fish are more frequently represented in the Middle Woodland assemblage. Overall, the plant data indicate that the Middle Woodland assemblages have a higher species diversity than the Early Woodland assemblages. The animal data indicate similar species diversity within the Early and Middle Woodland assemblage.

The plant macroremains and zooarchaeological assemblage inform about specific processing activities represented in the assemblages using wood charcoal patterning, butchery patterns, burned bone frequencies and characteristics, and fragmentation ratios (Table 6.56). Burning activities involving wood charcoal were more intensive and frequent during the Middle Woodland as compared to the Early Woodland component. The amount of burned bone, however, remains fairly constant with both components exhibiting very high frequencies of fully calcined bone. Butchery patterns also indicate similarities, with cut marks for both the Early and Middle Woodland

Table 6.55. Summary of the Plant Macroremain and Zooarchaeological Assemblages

Description	Early Woodland	Middle Woodland
Seasonality	Late fall and winter	Fall, some evidence for late spring and summer
Plant Macroremains	Nutshell (acorn, walnut family, and black walnut) Squash rind Very few wild seeds	Nutshell (hickory, bitternut hickory, acorn, walnut family) Squash rind Few wild seeds
Zooarchaeological Assemblage	Predominantly medium/large mammals and white-tailed deer Turtle, bird, fish present in lesser amounts	Predominantly medium/large mammals and white-tailed deer Turtle, bird, fish present in lesser amounts
Diversity	Early Woodland less rich and less diverse than Middle Woodland Trends towards evenness but more so than Middle Woodland	Middle Woodland modestly richer and more diverse than Early Woodland Trends towards evenness but less so than Early Woodland

assemblages occurring on the lower leg portions of white-tailed deer and medium/large mammals. Roasting, bone marrow, and bone grease rendering are represented in both the Early and Middle Woodland assemblages. The combination of burned bone color attributes and the fragmentation ratio indicate that roasting activities are better represented in the Middle Woodland assemblage and bone marrow/grease extraction in the Early Woodland assemblage.

Table 6.56. Summary of the Early and Middle Woodland Processing Activities

Description	Early Woodland	Middle Woodland
Sitewide: Burning Activities	Less intensive burning activities as compared to Middle Woodland	More intensive burning activities as compared to Early Woodland
	Similar frequencies of burned bone	Similar frequencies of burned bone
Sitewide: Butchery	Lower leg portions of white-tailed deer and medium/large mammals	Lower leg portions of white-tailed deer and medium/large mammals
Sitewide: Roasting, Bone Marrow, Bone Grease	Overall bone marrow/grease better represented and less roasting as compared to the Middle Woodland	More evidence for roasting activities as compared to the Early Woodland, but marrow/grease processing represented
Cooking Pit Data	Lower densities of wood charcoal than Middle Woodland	Higher densities of wood charcoal than Early Woodland
	Cooking pits contain more unburned bone than burned bone	Cooking pits contain more unburned bone than burned bone
	Burned bone is typically calcined	Burned bone is typically calcined
	More intensive bone grease and less intensive bone marrow extraction	Bone is less fragmented than Early Woodland suggesting bone marrow and less intensive bone grease

CHAPTER 7. DISCUSSION AND CONCLUSIONS

Introduction

The primary thesis of this dissertation project tests for significant differences in community and community identity, as evidenced through culinary traditions and foodways, between Early and Middle Woodland groups in southeastern Wisconsin; the project further evaluates the nature of these differences and the relationship to increased interaction with Havana-Hopewell. This chapter addresses each of the five research questions, presented in Chapter 2, developed to test the two hypotheses based on the multiple lines of material evidence detailed in Chapters 5 and 6 (Figure 7.1). The answers to each of the research questions are used to evaluate each hypothesis. The results of this dissertation project, based on a comprehensive data set from a single site, the Finch site, establishes a model for southeastern Wisconsin. Study of data sets from other sites can subsequently be used to test and refine this model.

The chapter begins with a discussion of data generated by this dissertation research project to address the temporal context of the Finch site Early and Middle Woodland components as well as to gauge trends of extra regional interaction. The delineation of culinary traditions and foodways associated with the Early and Middle Woodland components at the Finch site necessitates a fined grained temporal framework to allow for sufficient chronological control. The intensification of extra-regional interaction is widely accepted as a key component of the Middle Woodland stage in southeastern Wisconsin (Benchley et al. 1997; Goldstein 1992; Salzer n.d., 1986; Stevenson et al. 1997). Following the discussion regarding the Finch site context, each research question is considered in turn. The chapter concludes with a formal evaluation of Hypothesis 1 and 2, using the data from the research questions and information generated as part of this dissertation research project.

Temporal Context of Early and Middle Woodland in Southeastern Wisconsin

As the primary research examines the relationship between intensification of interaction with Havana-Hopewell and formation of community, sufficient chronological control regarding the Early and Middle Woodland components from the Finch site, as well a thorough understanding of the broader regional pattern, is a crucial component of the dissertation research project.

Chronological questions are significant as they relate to the proposition that the Hopewell phenomena is a materialization of increased intensity of social, political, and economic relations among individuals, residential groups, and communities in a context of demographic and geographic transformation (Charles et al. 2004: King et al. 2011:502). Development of fine grained chronologies is a necessary component for understanding the processes leading to the appearance

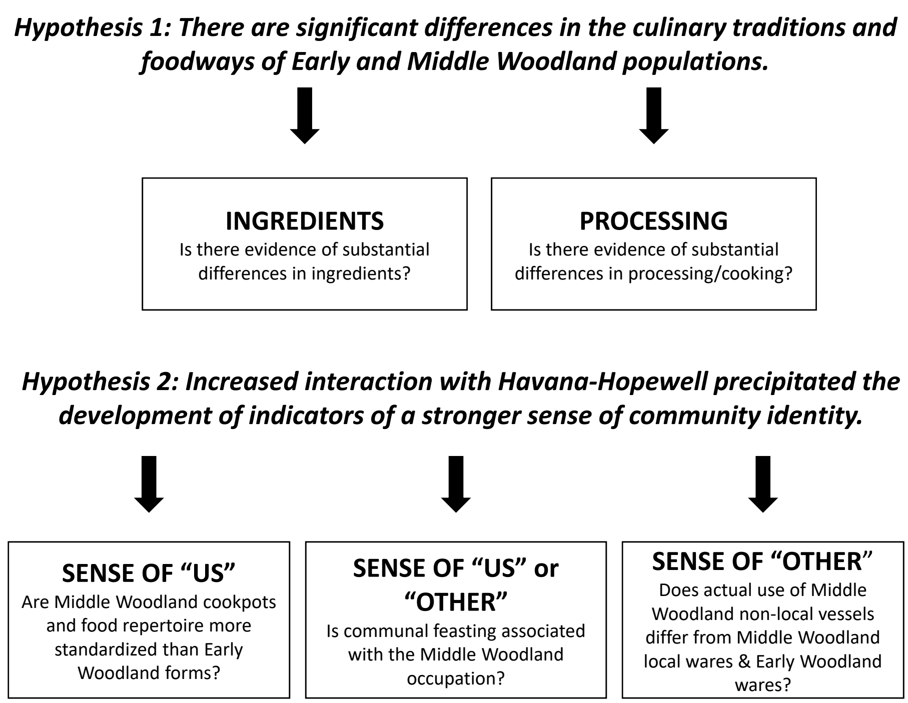


Figure 7.1. Hypotheses and research questions.

of Havana-Hopewell and Hopewell in various regions throughout the mid-continent as well as for empirically testing explanatory models of Havana-Hopewell and Hopewell origins (Chapman 2006; Keehner and Adair 2019; King et al. 2011).

Chronologies have been used as critical supporting evidence for the appearance of Havana-Hopewell and Hopewell across the mid-continent as either the result of a physical migration of people and/or the diffusion of ideas. The presence of Early Woodland populations within a region, the presence or absence of a continuous developmental sequence from Early to Middle Woodland, and the timing of the appearance of Havana-Hopewell and/or Hopewell traits are central to arguments regarding migration or diffusion (Brashler et al. 2006; Chivis 2016; Keehner and Adair 2019; Kingsley 1999). Significant gaps in chronology lend support to migration models. Such is the case for the Lower Illinois Valley, a region that lacks developmental continuity between the Prairie Lake Archaic, the Early Woodland Cypress (550 to 200 BC), and Havana-Hopewell, which appears at approximately 50 BC (Buikstra and Charles 1999; Charles 1985, 1992, 1995; Farnsworth 1986; Farnsworth and Asch 1986; King et al. 2011).

Evidence for the absence (or near absence) of populations in the valley is based on radiocarbon ages, ceramic typologies, and cemetery data (Buikstra and Charles 1999; Charles 1985, 1992, 1995; Farnsworth 1986; Farnsworth and Asch 1986; King et al. 2011). Uncalibrated radiocarbon dates from the region indicate an approximate estimated 150 year hiatus between late Early Woodland Black Sand (Cypress Phase - circa 200 BC) and initial Middle Woodland Havana (Mound House Phase - circa 50 BC) occupations (Farnsworth and Asch 1986; King et al. 2011). Ceramic material culture does not exhibit transitional forms from Cypress to Havana. Finally, cemetery distribution data indicates the low frequencies of Terminal Archaic and Early Woodland cemeteries as compared to Middle Woodland cemeteries (Charles et al. 1986).

Chronologies have challenged early models regarding the origins of Havana in western Michigan and northern Indiana as derived from a migration of peoples out of the central Illinois River Valley during the Fulton phase (200 BC to A.D. 200), traveling along the Kankakee River valley in northwest Indiana and into west Michigan (Brashler et al. 2006; Brown 1964; Flanders 1977; Garland and DesJardins 1995, 2006; Griffin 1952; Griffin et al. 1970; Kingsley 1981, 1990, 1999; Quimby 1941). Contemporary models classify Havana-Hopewell in western Michigan and northwestern Indiana, encompassing the Goodall and Norton-Converse Traditions, as a local phenomenon, with origins related to diffusion and the spread of ideology or information through interaction. The argument for diffusion is based on early Middle Woodland dates, evidence of Early Woodland occupations underlying Middle Woodland components, presence of very early Middle Woodland ceramic wares, and lack of sophistication in ceramic technology (Brashler et al. 2006; Chivis 2016; Kingsley 1999; Schurr 1997). Chivis (2016) argues these early Havana influences spurred the development of new forms of community identity among socially and temporally dynamic local populations. Recent AMS dates and recalibrated legacy radiocarbon dates indicate that Havana traits appear in western Indiana and northwestern Indiana between 150 BC to AD 30, corresponding with the early to middle Norton Phase in west Michigan and the North Liberty/Stillwell/early Goodall Phase in northwest Indiana (Chivis 2016:142-146). These early dates for Havana in western Michigan are derived from sites in the Muskegon River Valley (Jancarich, Schumaker Mounds), the Grand River Valley (Prison Farm), the Kankakee River Valley (12MR4), and the St. Joseph River Valley (Moccasin Bluff). Recent research into Kansas City Hopewell including detailed chronological and comparative ceramic analysis, suggests that the complex has local Early Woodland antecedents. Moreover, while Illinois Havana influence is present, the Kansas City Hopewell ceramics align more closely with Hopewell centers to the south such as Cuesta-Copper in Arkansas and Marksville in the lower Mississippi River Valley (Keehner and Adair 2019).

Current cultural-historical frameworks for southeastern Wisconsin assume a sequential temporal ordering of the Early Woodland and Middle Woodland periods; however, the region has yielded very few radiocarbon dates for these periods (Richards and Jeske 2015; Salkin 1986). Most Early and/or Middle Woodland archaeological sites in southeastern Wisconsin harbor multiple components. Archaeological sites exhibiting a long history of nearly continuous occupation not only reflect a deep connection to the landscape, but also long-standing choices regarding seasonal settlement patterning and placement of living, working, and ritual areas (Goldstein 1982; Jeske 2006). Archaeological data indicates that, by the later Early Woodland, widespread and fairly intensive occupations were present in several regions of southeastern Wisconsin including areas around Lake Waubesa (Yahara River), Lake Koshkonong (Rock River), the Onion River, and along interior tributaries east of Lake Michigan (Haas 2019; Jones et al. 2015; Rusch 1988; Salkin 1986; Salzer n.d., 1965). These well adapted and successful later Early Woodland groups may have been reluctant to participate in the cultural, technological, and religious innovation of the Hopewell Interaction Sphere, adopting only a limited number of traits and trade items (Salkin 1986, 1989, 2003; Stevenson et al. 1997). Alternatively, some researchers suggest that, based on the clustering of Middle Woodland sites along the Rock River (and Lake Koshonong) and Madison's four-lakes area (Yahara River), such sites reflect an intrusion of small populations from Illinois carrying a local variant of Havana-Hopewell with them (Salkin 1994, 2003; Stevenson et al. 1997).

The current understanding of the later Early Woodland and Middle Woodland in southeastern Wisconsin attests to underlying complexity and social dynamics of this time period. The questions surrounding the timing and relationships of Early and Middle Woodland populations is not only an issue in southeastern Wisconsin, as complex situations are noted in northeastern Wisconsin and in southwestern Wisconsin (Mason 1986, 1990; Overstreet 1993; Stoltman 1990, 2005, 2006). At the Mero site in northeastern Wisconsin, IOCM ceramics occur in direct stratigraphic association with North Bay Middle Woodland ceramic wares. This co-occurrence, along with the observation that IOCM wares grades into later types, led Mason (1966) to conclude that IOCM wares had little value as horizon markers (Mason 1966; Overstreet 1993).

In southwestern Wisconsin, the late Early Woodland and Middle Woodland (circa AD 1 to 400) is understood as a continuum of cultural development from Prairie Phase (variant of Black Sand) to Trempealeau to Millville into which Havana influences were differentially introduced as the result of intermittent but persistent cultural interaction (Stoltman 2005, 2006). Prairie ware and Havana ware pots co-occur, and are co-eval, at several sites (Collins and Forman 1995; Johansen et al. 1998; Stoltman 2005, 2006). At the Mill Coulee site (47CR0100) a hybrid Praire ware - Havana ware vessel was recovered from a shallow pit feature (Stoltman 2006). The archaeological data from southwestern Wisconsin suggests that Early Woodland pots were still being manufactured when cultural interaction had begun with the Havana tradition.

Radiocarbon Record of Southeastern Wisconsin

The Early and Middle Woodland periods in southeastern and eastern Wisconsin has a limited radiocarbon record (Benchley et al. 1997; Wolforth 1995). In southeastern Wisconsin, the earliest portion of the Woodland stage (Stoltman 1979) is marked by the presence of thick ware pottery dated to circa 860 to 460 BC (Benchley et al. 1997; Boszhardt 1977; Kehoe 1975). The later Early Woodland stage, denoted by the appearance of thinner walled incised-over-cordmarked (IOCM) pots, dates to early in the first century AD (Benchley et al. 1997; Salkin 1986; Stoltman 1986). The later dates on IOCM pottery suggests a time transgressive phenomenon, as these vessels may co-occur with Middle Woodland forms (Benchley et al. 1997:109). This has led Stoltman (1990:255) to comment that:

> The Early Woodland stage is represented by two phases, Indian Isle and Prairie, which appear to be regional variants of the widespread Marion and Black Sand cultures, respectively. In both cases radiocarbon dates pertaining to these phases are younger (more recent) than those for comparable complexes to the south, raising the possibility of time-transgressive instead of time-parallel relationship between homotaxial complexes in Illinois versus the Upper Mississippi Valley [Stoltman 1990: 255].

As such, the Early Woodland in southeast Wisconsin is conventionally dated from circa 500 BC to AD 100 and Middle Woodland from AD 100 to 400 (Stevenson et al. 1997). However, there are few radiocarbon dates from Early and Middle Woodland components in southeastern Wisconsin, with an even smaller number of dates that provide a direct date of a diagnostic artifact. As such, the Early and Middle Woodland date ranges rely heavily on cross dating and comparison to sites in Illinois (Goldstein 1982). The Early and Middle Woodland radiocarbon record for other portions of Wisconsin is as meager as the data for southeastern and eastern Wisconsin. Several noteworthy Early Woodland dates are known from northeastern Wisconsin. A Marion Thick vessel from the multi-component Lasley's Point site is directly dated to 2500±40 BP (2-sigma cal 793-486 BC) (Richards and Jeske 2015). Wild rice from the Alonzo Kellogg site on the shore of Lake Poygan (Winnebago County) dates to the Early Woodland period 2300± 40 (427 BC to 206 BC) (Hart et al. 2007; Overstreet et al. 2004). A Dane Incised vessel from the Shanty Bay site (47DR0011) on the Door peninsula produced a calibrated date of 359 BC to 51 BC (Dirst 1995).

As part of the dissertation project, an inventory and assessment of extant radiocarbon dates from Early and Middle Woodland contexts in southeastern Wisconsin, including dates from the Finch site, was undertaken to establish a regional chronology. The chronology is then used to provide an appropriate context for the Finch site Early and Middle Woodland components and to assess the timing of Havana-Hopewell interaction and intensification in southeastern Wisconsin.

Based on a review of published and unpublished documents, 25 dates derived from ten sites complete the radiocarbon record for the Early and Middle Woodland in southeastern Wisconsin. The 25 reported and uncalibrated dates were calibrated in OxCal 4.3 using IntCal13calibration curve. The uncalibrated dates, calibrated dates, and calibrated medians are presented in Table 7.1 to Table 7.2 and calibrated plots in Figure 7.1. The calibrated median of the probability curve is included as it reflects a more robust temporal estimator as compared to the intercepts (King et al. 2011; Telford et al. 2004). Although the calibrated median does not describe the full range of probable calendar dates, it allows for greater interpretative potential while remaining sensitive to the indeterminacy of estimates with overly broad countering errors (King et al. 2011). The southeastern and eastern Wisconsin radiocarbon record includes a single date from a Late Archaic context, the Merles Creek site (47JE1054), provided to reference a beginning temporal point for the Early Woodland. Few of the reported dates (n=7) reflect the direct dating of diagnostic material culture. Most dates (n=18) derive from organic material recovered from contexts yielding diagnostic material and/or proveniences associated with Early and/or Middle Woodland contexts.

Dates for the earliest portion of the Early Woodland are derived from two sites: the Hilgen Spring Park Mounds (47OZ007) (Van Langen and Kehoe 1971; Kehoe 1975) and the Alberts site (Jeske and Kaufman 2000). The four dates from these sites are derived from wood charcoal and produced calibrated median dates ranging from 949 BC to 522 BC. At the Alberts site (47JE0903), wood charcoal recovered from a large pit situated at the south edge of a conical mound yielded a date of 2730±70 BP. As the Alberts site defines a multi-component site harboring Late Archaic through Late Woodland components, the radiocarbon date may relate to either the Late Archaic and/or early part of the Early Woodland. At least two thick ware type vessels were identified at the Alberts site along with several diagnostic Late Archaic hafted biface forms (Table Rock, Durst, and Fox Valley stemmed) (Jeske and Kaufman 2000). All of the early Early Woodland dates in southeastern Wisconsin post date the 1148 BC date (calibrated mean) from the Late Archaic Merles Creek site.

At the Hilgen Spring Park Mounds site, two of the three mounds were excavated revealing burials and rock concentrations (Kehoe 1975). The mound fill and sub-mound midden and features produced thick, Early Woodland pottery, a contracting stem point, a stone gorget, lithic debris, animal bone, charcoal and shell habitation debris (Benchley et al. 1997). A Middle Woodland Monona stemmed point was also found in a sub-mound context. Radiocarbon dates from wood charcoal in the sub-mound middens and rock features ranged from 2790±65 BP to 2410±55 BP (Benchley et al. 1997; Kehoe 1975; Van Langden and Kehoe 1971). Although the middens and hearths are generally recognized as Early Woodland, not all researchers support the Early Woodland affiliation of the mounds (Boszardt et al. 1986).

Dates for the later portion of the Early Woodland, associated with IOCM ceramic wares and Waubesa hafted biface forms, have been obtained from four sites in southeastern and eastern

Table 7.1. Radiocarbon Dates from Early and Middle Woodland Contexts in Southeastern and Eastern Wisconsin (continues).

Lab Number	Site	Description	14C age years BP	Calendar BC AD (2 Sigma Range)	Era	Calibrated Median	Reference
BETA 140466	Merles Creek (47JE1054)	Organic from pit feature	2940±90	1395 BC to 920 BC	Late Archaic	1148 BC	Meinholz and Hamilton
WIS 647	Hilgen Spring Park Mounds (47OZ0007)	Wood charcoal from feature on surface of cleared mound floor	2790±65	1112 BC to 816 BC	Early Woodland	949 BC	Kehoe 1975
BETA 140639	Alberts Site (47JE0903)	Wood charcoal below mound	2730±70	1094 BC to 795 BC	Late Archaic	BC 891	Jeske 2006
WIS 643	Hilgen Spring Park Mounds (47OZ0007)	Charcoal from feature in mound fill	2475±65	777 to BC 412	Early Woodland	611 BC	Kehoe 1975
WIS 345	Hilgen Spring Park Mounds (47OZ0007)	Charcoal from hearth on floor of mound 1	2410±55	522 BC to AD296	Early Woodland	522 BC	Kehoe 1975
ISGS A1107	Crabapple Point Locality	Kegonsa Stamped vessel residue	2365±40	BC 731 to BC 376	Middle Woodland	453 BC	Richards and Jeske 2015
WIS 1715	Bachmann (47SB0202)	Wood charcoal from hearth	2320±80	751 BC to 196 BC	Early Woodland	400 BC	Rusch 1988
BETA 215013	Plantz (47WN0325)	Nutshell in feature matrtrix	2090±40	333 BC to AD 2	Middle Woodland	BC 113	Meinholz and LaFleur 2006
WIS 1861	Bachmann (47SB0202)	Wood charcoal from hearth	2080±70	356 BC to AD 66	Early Woodland	107 BC	Rusch 1988
UGAMS 28221	Finch (47JE0902)	Shorewood Cord Roughened vessel residue	2060±25	166 BC to AD 1	Middle Woodland	78 BC	See Chapter 4
WIS 1890	Bachmann (47SB0202)	Wood charcoal from hearth	2050±80	351 BC to AD 86	Early Woodland	72 BC	Rusch 1988
UGAMS 28222	Finch (47JE0902)	Kegonsa Stamped vessel residue	1980±20	39 BC to AD 66	Middle Woodland	AD 24	See Chapter 4
WIS 1213	Outlet (47DA0003)	Human bone collagen	1960±80	166 BC to AD 230	Middle Woodland	AD 37	Bender et al. 1982
UGAMS 28220	Finch (47JE0902)	Dane Incised vessel residue	1930±25	AD 21 to 129	Early Woodland	AD 72	See Chapter 4
WIS-1437	Beach Site (47DA0459)	Wood charcoal from feature with Beach Incised vessel	1930±70	101 BC to 244 AD	Early Woodland	AD 74	Salkin 1986
ISGS A1237	Outlet (47DA0003)	Shorewood Cord Roughened vessel residue	1920±40	19 BC to AD 214	Middle Woodland	AD 83	Bender et al. 1982
BETA 411374	Kohler (47SB0173)	Fishbone in thermal feature that contained IOCM vessel	1900±30	AD 28 to AD 214	Early Woodland	AD 103	Jones et al. 2015
BETA 411373	Kohler (47SB0173)	Wood charcoal in hearth feature	1880±30	AD 66 to AD 222	Middle Woodland	AD 123	Jones et al. 2015

Wisconsin: Bachmann, Finch, Beach, and Kohler (Table 7.1, Table 7.2). The date from the Finch site is derived from residue adhering to an IOCM vessel. The dates from the other sites are based on organic material recovered from pit features. At the Beach and Kohler sites, the pit feature organics were in association with IOCM pottery. The calibrated two-sigma range on the later Early Woodland dates range from 751 BC to AD 216. Calibrated medians range from 400 BC to AD 103. Notably, the calibrated medians from the Finch site, Beach site, and Kohler site are relatively similar, respectively producing dates of AD 72, AD 74, and AD 103. The limited radiocarbon record for the later Early Woodland suggests IOCM pottery continued to be manufactured during the first century AD.

Six sites have yielded radiocarbon dates for the Middle Woodland period including Crabapple Point, Plantz, Finch, Outlet, Kohler, and Peterson (Table 7.1; Table 7.2). The dates are derived

Table 7.2. Radiocarbon Dates from Early and Middle Woodland Contexts in Southeastern and Eastern Wisconsin (concluded)

Lab Number	Site	Description	14C age years BP	Calendar BC AD (2 Sigma Range)	Era	Calibrated Median	Reference
BETA 215014	Plantz (47WN0325)	Nutshell in feature matrtrix	1850±40	AD 68 to AD 251	Middle Woodland	AD 166	Meinholz and LaFleur 2006
UGAMS 2721	Peterson (47WK0199)	Steuben Punctated	1840±80	AD 8 to 382	Middle Woodland	AD 180	Richards and Jeske 2015
UGAMS 2720	Peterson (47WK0199)	Hopewell ware	1800±80	AD 55 to 401	Middle Woodland	AD 224	Richards and Jeske 2015
UGAMS 33333	Finch (47JE0902)	Bitternut hickory in feature with Shorewood Cord Roughened & Havana Wares	1790±20	AD 178 to 325	Middle Woodland	AD 237	See Chapter 4
BETA 411374	Kohler (47SB0173)	Wood charcoal from house feature that contained MW vessel	1550±30	AD 423 to 574	Middle Woodland	AD 488	Jones et al. 2015
WIS 1217	Outlet (47DA0003)	Human bone (charred)	1540±70	AD 390 to AD 645	Middle Woodland	AD 509	Bender et al. 1982
WIS 1243	Outlet (47DA0003)	Human bone (charred)	1360±70	AD 545 to AD 863	Middle Woodland	AD 669	Bender et al. 1982

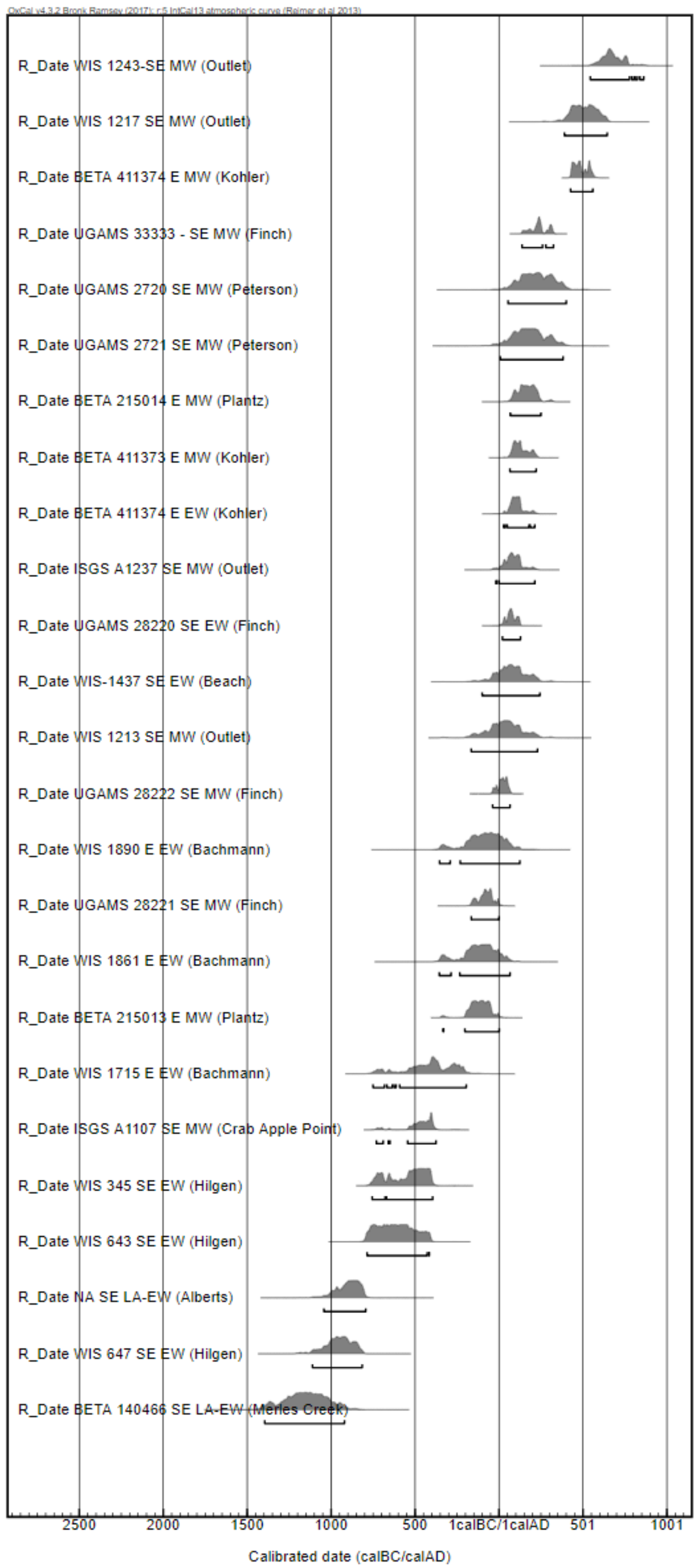


Figure 7.1. Southeastern and eastern Wisconsin calibrated AMS dates based on data in Table 7.1 and Table 7.2. Calibration completed in OxCal 4.3 using IntCal13calibration curve.

from residue adhering to Kegonsa stamped vessels (Crabapple Point, Finch), Shorewood Cord Roughened vessels (Outlet, Finch), a Steuben Punctated vessel (Peterson), Hopewell ware (Peterson), charred human bone and bone collagen (Outlet), and organics from pit feature fill (Kohler, Finch, and Plantz). The Middle Woodland dates have a wide two sigma range, spanning over a millennia, from 731 BC to AD 863, and calibrated median dates from 453 BC to AD 669.

Box plots compare the range of calibrated AMS medians to summarize the radiocarbon data associated with the Early and Middle Woodland periods in southeastern and eastern Wisconsin (Figure 7.2). The dates from Merles Creek and Alberts site are included as Late Archaic dates for comparison with the early portion of the Early Woodland period. The Early Woodland calibrated medians range from 949 BC to AD 103, with a mean of 268 BC and median of 107 BC. No outliers are identified as associated with the Early Woodland dates. The Middle Woodland calibrated

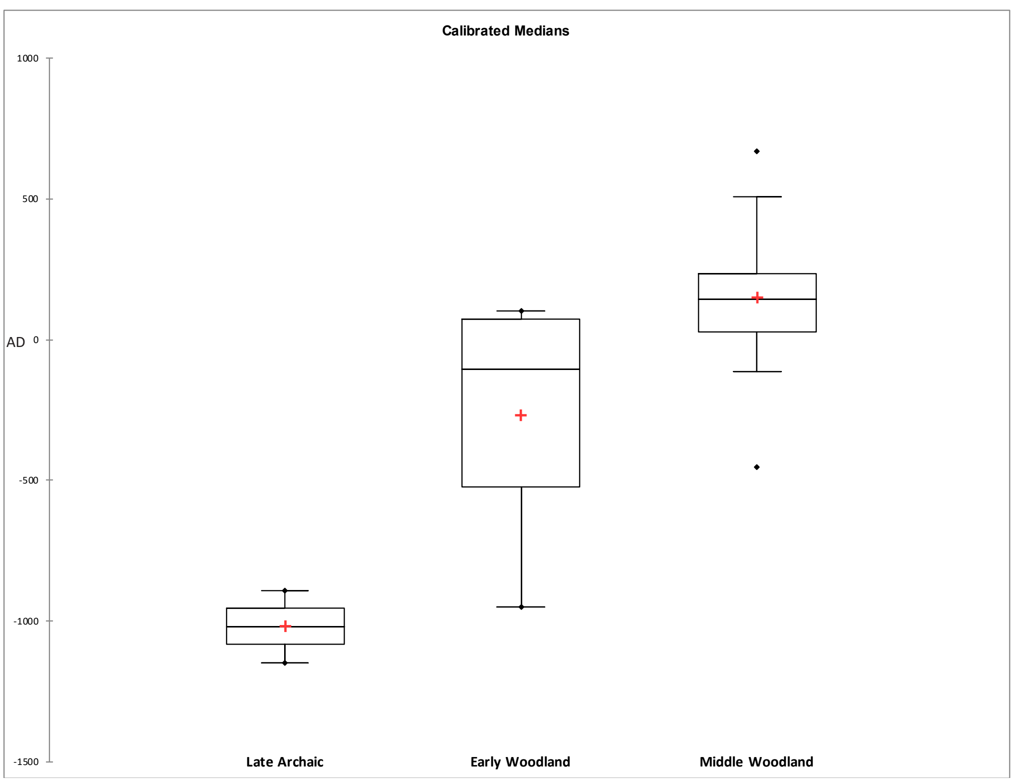


Figure 7.2. Box plots of calibrated median AMS dates from southeastern and eastern Wisconsin based on data in Table 7.1 and Table 7.2)

medians range from 453 BC to AD 669 with a mean of AD 150 and median of AD 145. Two outliers are identified for the Middle Woodland dates, Kegonsa Stamped vessel residue from the Crabapple Point locality (ISGSA1107) and charred human bone from the Outlet site (WIS 1243). The box plots reveal overlapping date ranges for the Early and Woodland periods. The mean and median of the calibrated Middle Woodland dates, however, are later than the Early Woodland dates.

In order to further explore the radiocarbon record of the later Early Woodland and Middle Woodland components, and in an attempt to narrow the date ranges associated with each component, the Late Archaic contexts, early Early Woodland dates from Alberts site and Hilgen Spring Mound Group, and the two Middle Woodland outliers are removed from the data analysis (Figure 7.3; Table 7.3). The Early Woodland calibrated medians range from 400 BC to AD 103 with a median of 0 AD and mean of 55 BC. Overall, the calibrated two sigma range for Early Woodland dates extends from 751 BC to AD 214. One outlier is identified, a calibrated 400 BC date from the Bachmann site, derived from wood charcoal within a pit feature. The calibrated medians for Middle Woodland components range from 112 BC to AD 509 with a median of AD 145 and mean of AD 157. The calibrated two sigma range for Middle Woodland dates extends from 333 BC to AD 645. The resulting summary data, based on the calibrated medians continue to indicate an overlap of Early and Middle Woodland components, although the Middle Woodland components median and mean is later than that of the Early Woodland.

Although the radiocarbon record of southeastern Wisconsin is meager, and further limited by few direct dates of diagnostic forms, there are two notable patterns regarding the later Early Woodland and Middle Woodland. First, the dates indicate an overlap between the later Early Woodland and the first portion of the Middle Woodland period. Based on calibrated medians, this overlap is approximately from 112 BC to AD 103. As such, during this period of overlap, both IOCM late Early Woodland pottery and Middle Woodland ware types were likely both manufactured. The Finch site Early and Middle vessels fall into this period of overlap, with calibrated median

Table 7.3. Summary of Radiocarbon Dates from Early and Middle Woodland Contexts in Southeastern and Eastern Wisconsin

	Two Sigma Range	Calibrated Median Range	Median	Mean
Early Woodland	751 BC to AD 214	400 BC to AD 103	AD 0	55 BC
Middle Woodland	333 BC to AD 645	112 BC to AD 157	AD 145	AD 157

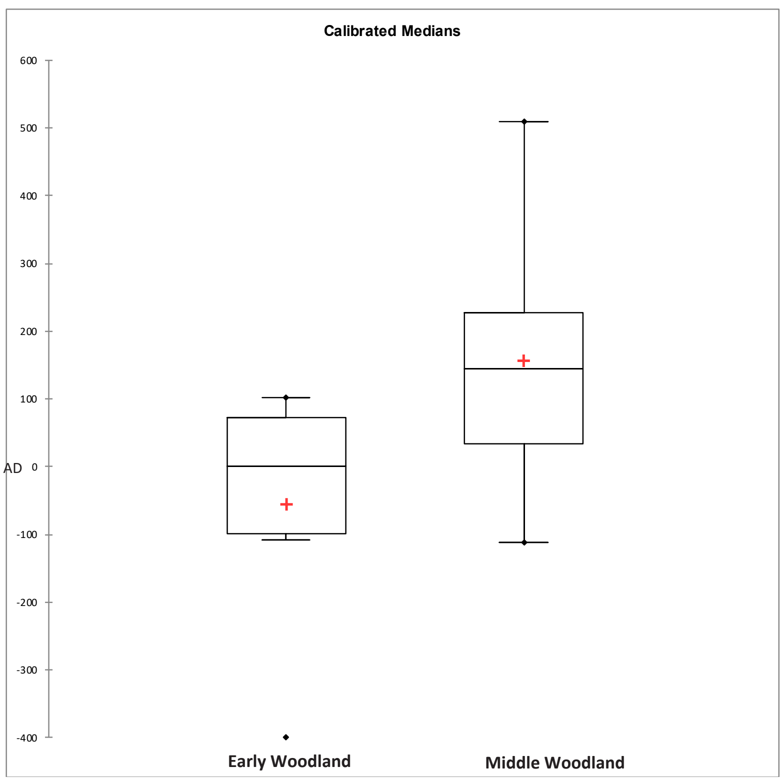


Figure 7.3. Box plots of calibrated median AMS dates from southeastern and eastern Wisconsin based on data in Table 7.1 and Table 7.2), omits WIS 1243, ISGSA1107, Hilgen Spring Park Mounds (WIS 647, WIS 643, WIS 345), Alberts site, and Merles Creek Site (BETA140466).

AMS dates of an IOCM vessel at AD 72, Kegonsa Stamped at AD 24, and Shorewood Cord Roughened at 78 BC. The later Early Woodland component associated with IOCM wares at the Beach, Bachmann, Outlet, and Kohler sites, as well as a Shorewood Cord Roughened vessel from the Oulet site, yielded dates that fall within this period of overlap. The southeastern Wisconsin data appears to parallel the late Early Woodland-Middle Woodland dynamics observed both in southwestern Wisconsin and northeastern Wisconsin, where late Early Woodland and Middle Woodland wares co-occur and are also co-eval (Mason 1966; Johnasen et al. 1998; Stoltman 1990, 2005, 2006). Given the overlapping dates, it is unlikely that the Middle Woodland presence in southeastern Wisconsin represents a physical migration of Havana peoples from the south (sensu Salkin 1986).

The radiocarbon record suggests that Havana-Hopewell wares tend to occur later than the "local" Middle Woodland pots, represented by Shorewood Cord Roughened and Kegonsa Stamped, as well as IOCM wares. Median AMS dates of Havana-Hopewell vessels are AD 180 (UGAMS 2721), AD 224 (UGAMS2720), an AD 237 (UGASM 3333) and are derived from the Peterson and Finch sites. This observation is considered provisional, as there are only three dates that provide an assessment of Havana-Hopewell wares.

The Middle Woodland dates from the Finch site, as well as southeastern Wisconsin more broadly, fit well within Middle Woodland developments outside the region. In the Lower Illinois Valley and American Bottom, Middle Woodland extends from 100 BC to AD 400 (King et al. 2011). The Holding Phase, the "Hopewell horizon" in the American Bottom dates to AD 50 to 200 (Fortier 2001, 2008; McElrath and Fortier 2000). A bit closer to southeastern Wisconsin, in lower Michigan, diffusion of Havana information and technology begins as early as 150 BC and by AD 30 new forms of community are recognized, developing in response to Havana-Hopewell interaction (Chivis 2016). The southeastern Wisconsin data indicate that Havana influence may have occurred early on, but there is little evidence for physical migration of Havana-Hopewell into southeastern Wisconsin.

Interaction

Middle Woodland in southeastern Wisconsin is associated with an intensification of interaction with Havana-Hopewell populations from the south (McKern 1942; Salzer 1986; Stevenson et al. 1997). Archaeological evidence for this intensification is derived from mound mortuary ceremonialism as well as the occurrence of distinctive stylistic elements on pottery vessels, lithic technological forms, and a marked increase in exotic stone resource use (McKern 1942; Salzer n.d., 1986). The Middle Woodland stage also marks the appearance of curved and straight based platform type pipes manufactured from pipestone deposits in western Wisconsin, Minnesota, and, less commonly, Ohio (Sabo 2007; Salzer n.d.).

Although classic Hopewell Interaction Sphere items are rare at domestic sites in the southeastern Wisconsin, Salzer's (n.d., 1965) investigations at Cooper's Shores and Highsmith revealed higher frequencies of non-local cherts, especially Dongola chert, associated with the Middle Woodland occupation compared to the Early Woodland component. Moreover, Salzer (n.d.) noted a tendency for comparatively more Middle Woodland chipped stone tools that were manufactured from non-local materials than Early Woodland tools. As such, relative frequencies of non-local lithic raw materials were compared between the Early and Middle Woodland components at the Finch site to gauge interaction. The results indicate a remarkable similarity of the raw material profiles of waste flakes and stone tools for Finch site Early and Middle Woodland components. Lithic assemblages for both components are predominantly of local cherts, namely Galena chert. Non-local cherts are present in both assemblages, with Burlington chert composing the most abundant non-local type for the Early and Middle Woodland component. The data indicate a modest increase in non-local raw material for chipped stone tool manufacture associated with the Middle Woodland component compared to the Early Woodland component. Moreover, the non-local raw materials represented in the assemblages indicate that interaction with groups to the south were initiated by the time of the Early Woodland component; the raw materials further indicate that this interaction included not only with groups to the south but groups in northeastern and southwestern Wisconsin, and farther to the west.

Hypothesis 1: There are significant differences in the culinary traditions and foodways of Early and Middle Woodland populations.

Hypothesis 1 evaluates evidence for differences in culinary traditions and foodways between Early Woodland and Middle Woodland groups. The identification of culinary traditions and foodways is accomplished through a qualitative and quantitative examination of ingredients and cooking/processing techniques that compose culinary traditions and foodways. Two research questions test Hypothesis 1 using the Finch site archaeological data.

Research Question 1: Is there evidence of a substantial difference in ingredients?

The data set used to address this research question consists of a formal comparison of the Early and Middle Woodland component plant and animal assemblages, as well as the results of the chemical residue analysis conducted on a sample of the Early and Middle Woodland vessels.

The Early Woodland and Middle Woodland assemblages are similar in terms of overall plant and animal composition. Both are characterized has having high frequencies of wood charcoal, moderate to high amounts of nutshell, and low frequencies of squash rind and wild seed taxa. Domesticates, consisting of squash (*Cucurbita* sp.) rind, are present in both assemblages; the Middle Woodland assemblage has evidence of a second type of domesticate, tobacco (*Nicotiana* sp.). Animal taxa represented in the Early and Middle Woodland assemblages consist of very high quantities of mammal remains with low representation of bird, fish, and reptiles.

Taxa represented in the Early Woodland assemblage includes four plant and five animal species/types. The plant taxa consist of two nut taxa (black walnut and acorn), squash rind, and a single wild nightshade family (Solanaceae) seed that likely represents incidental inclusion. The identified animal species are wolf/coyote/dog (Canis), elk (*Cervus canadensis*), even-toed ungulate

(Artiodactyl), white-tailed deer (*Odocoileus virginianus*), and turtle (Testudines). Unidentified bird and fish remains are also present in the Early Woodland assemblage.

Taxa represented in the Middle Woodland assemblage consist of nine plant and eight animal species/types. The plant taxa consist of nuts (hickory, acorn, bitternut hickory, and hazelnut), squash rind, and wild seeds (spurge, bedstraw, knotweed) and tobacco. The spurge, bedstraw, and knotweed likely represent incidental inclusions in the assemblage; the association of tobacco with the Middle Woodland component is provisional. The identified animal species are channel catfish (*Ictalurus punctatus*), even-toed ungulate (Artiodactyl), skunk (*Mephitis mephitis*), muskrat (*Ondatra zibethicus*), raccoon *(Procyon lotor*), white-tailed deer (*Odocoileus virginianus)*, and turtle (Testudines). Unidentified bird remains are also present in the assemblage.

Plant and animal species common to the Early and Middle Woodland components include walnut family (Juglandaceae) nutshell, acorn (*Quercus* sp.) nutshell, squash rind (*Curcurbita* sp.), white-tailed deer (*Odocoileus virginianus*), even-toed ungulate (Artiodactyle), and turtle (Testudines). The Early and Middle Woodland assemblages also include unidentified fish and bird species.

Several plant and animal species are distinct to the Early and Middle Woodland components. The Early Woodland component yielded black walnut *(Junglas nigra*), wolf/coyote/dog (Canis), and elk (*Cervus canadensis*) that were not identified as part the Middle Woodland assemblage. Represented in the Middle Woodland assemblage but not in the Early Woodland assemblage are hickory nutshell (*Carya* sp.), hazelnut (*Corylus* sp.), bitternut hickory *(Carya cordiformis*), channel catfish (*Ictalurus punctatus*), and skunk (*Mephitis mephitis*), muskrat (*Ondatra zibethicus*), raccoon (*Procyon lotor*), as well as a few wild seed varieties.

The ratio of specific *plant taxa : plant weight* for nutshell, squash rind, and wild seeds indicates that nuts are the major plant food constituent for both the Early and Middle Woodland components. The higher value of *nutshell : total plant weight* represented in the Middle Woodland assemblage suggests that nuts contributed slightly more to the overall diet in the Middle Woodland compared to the Early Woodland occupation. Although some nut types are common to both components, such as acorn and walnut family, some nuts are unique to each component, reflecting distinct preferences. Black walnuts are only associated with the Early Woodland while hickory, hazelnut, and bitternut hickory are associated with the Middle Woodland component. The differences in nut preferences concords with data regarding burning intensity at the site that reveal higher frequencies and ubiquity of wood charcoal associated with the Middle Woodland components; hickory and acorn nutshell require extensive processing, involving boiling, stewing, and/or parching/roasting, prior to consumption whereas black walnuts can be easily hand picked to remove the nut meat. Squash rind and wild seeds contribute much less to the overall plant food assemblage for both the Early and Middle Woodland components, however, based on the standardized ratio, these plant types may be slightly more important for the Middle Woodland compared to the Early Woodland.

Quantitative analysis of plant foods is limited to nutshell as too few wild seeds and squash rind were recovered to allow for meaningful comparison. Examining all nutshell derived from feature contexts associated with the Early and Middle Woodland components indicates that there is no statistically significant difference in nutshell abundance between these occupations. Nutshell, squash rind, and wild seeds are more ubiquitous in the Middle Woodland component compared to the Early Woodland occupation suggesting more prevalent use associated with the Middle Woodland.

Three of top five most ubiquitous plant taxa are the same for both the Early and Middle Woodland assemblages. These three taxa are walnut family (Juglandaceae) nutshell, squash (*Cucurbita* sp.) rind, and acorn (*Quercu*s sp.) nutshell.

Examining the zooarchaeological data, the taxa composition of the Early and Middle Woodland components are nearly identical. Both are characterized, using NISP and bone weight, as having very high frequencies of mammal remains, especially white-tailed deer, with low to very low frequencies of bird, fish, and reptile remains. Based on counts and weights of mammal derived from feature contexts, there are no statistically significant differences in mammal abundance between the Early and Middle Woodland occupations. However, based on frequencies measured across the components, all mammals and white-tailed deer have higher frequencies in Middle Woodland contexts than Early Woodland contexts.

In addition to the heavy representation of white-tailed deer for both components, turtle, bird, and fish appear in both Early and Middle Woodland assemblages. Turtles are more common in the Early Woodland assemblage, while bird and fish are more frequently represented in the Middle Woodland assemblage. Overall, the plant data indicate that the Middle Woodland assemblages have a higher species diversity than the Early Woodland assemblages. The animal data indicate similar species diversity within the Early and Middle Woodland assemblage.

Chemical residue analysis was completed for a small sample of the Early and Middle Woodland vessels. Nearly all of the vessels yielded evidence of both animal and plant products, mostly lean large herbivore flesh and low to medium fat content plants. The residue analysis concords with the use wear analysis that concluded most Early and Middle Woodland pots were used for multiple functions with use intensity ranging from light to heavy. There is lack of an overall differentiation, based on residue profiles, between the Early Woodland and Middle Woodland vessels.

There are, however, a few subtle differences in the residue profiles of the Early Woodland, local Middle Woodland, and Havana ware vessels. Two Early Woodland vessels yielded medium fat content plant or animals that were not detected in the Middle Woodland vessels. Medium fat content lipid profiles relate to corn and fish; as corn is an unlikely candidate for an Early Woodland vessel, the residue may relate to fish. The local Middle Woodland vessel yielded the only evidence of nut oil; this lipid category was absent from the Early Woodland vessels and the Havana ware vessels. Finally, the Havana ware vessels produced evidence of herbivore bone marrow and medium-low fat content plants that are absent from the Early Woodland and local Middle Woodland vessels. Moreover, in one Havana ware vessel, the herbivore signature was noted as “nicely marbled” indicating a fattier cut of meat that was prepared in the vessel (Malainey and Figol 2017; Appendix I).

In sum, the ingredients associated with the Early Woodland component, based on taxonomic representation and quantification measures, are nuts (black walnut, acorn, and walnut family), squash rind, medium/large mammals (mostly white-tailed deer and even-toed ungulate), and turtle.The ingredients associated with the Middle Woodland component are nuts (hickory, acorn, hazelnut, bitternut hickory, and walnut family), squash rind, medium/large mammals (mostly white-tailed deer and even-toed ungulate), and turtle. The most abundant and ubiquitous animal taxa are the same for the Early and Middle Woodland components, consisting of medium/large mammals, white-tailed deer, even-toed ungulate, and turtle. The most abundant and ubiquitous plant taxa for the Early and Middle Woodland occupations is nutshell, however, different varieties of nuts are represented within each component.

Based on the Finch site data, the plant macroremains, zooarchaeological assemblage, and chemical residue analyses indicate only very slight changes in ingredients between the Early and Middle Woodland components. Both the Early and Middle Woodland site occupants included heavy use of nuts and medium/large mammals, especially white-tailed deer. Nuts were important for both components but may have been slightly more so for Middle Woodland groups. Minor differences between the components relate to the type of nuts harvested, with Early Woodland emphasizing more black walnut and Middle Woodland more hickory nutshell. The differences in nut preference is consistent with data generated about fire intensity and lipid residue profiles. Domesticates, consisting of squash (*Cucurbita* sp.), were associated with both the Early and Middle Woodland components; the Middle Woodland assemblage further yielded evidence of tobacco (*Nicotiana* sp.).

Research Question 2: Is there evidence of substantial differences in processing/cooking techniques?

The Early and Middle Woodland components at the Finch site reflect a domestic habitation with numerous features and are characterized by high quantities of grit-tempered cook pots (all jars) and well preserved animal bone and charred plant remains. The Early and Middle Woodland processing techniques are inferred from aspects of the ceramic functional analysis as well as the plant macro-remains and zooarchaeological assemblage (Table 7.4). Ceramic vessel design, hearth arrangement, cooking types and modes, intensity and frequency of activities involving fire, preferred animal types and portions, and animal processing methods collectively provide a robust assessment of processing techniques. The characteristics used to evaluate processing are summarized in Table 7.4.

All Early and Middle Woodland vessels from Finch are jars and are characterized as three types: small, thin-walled globular jars; medium/larger thicker-walled conoidal (and sub-conoidal) pots; and small, thin-walled neckless jars. The different forms were likely designed to be used for different types of cooking related and food preparation tasks. The globular jars are most suited

Table 7.4. Early and Middle Woodland Processing Techniques

Processing Characteristic	Data Set	Early Woodland	Middle Woodland
Ceramic Vessel Design	Ceramics-Intended Function (Chapter 5)	Small vessels for rapid heating & boiling with easy access to contents	Medium/large vessels for long term simmering with easy access to contents; small vessels for rapid heating & less accessible
Hearth Placement	Ceramics-Actual Function (Chapter 5)	Placed in or over fire	Placed in or over coals
Cooking Type & Mode	Ceramics-Actual Function (Chapter 5)	Direct heat, dry (roasting) or wet (simmering, stewing) with light to heavy use; Other vessels possibly for indirect heating	Direct heat, wet mode (boiling, stewing) with heavy use. Pouring/ splattering of vessel contents
Intensity and frequency of activities involving fire	Plant Macroremains & Faunal (Chapter 6)	Less intensive & less frequent for wood charcoal. Higher relative frequencies of burned bone (weight)	More intensive & more frequent for wood charcoal. Lower relative frequencies of burned bone (weight)
Preferred animal types and portions	Faunal (Chapter 6)	Medium/large mammal, White-tailed deer, leg portions	Medium/large mammal, White-tailed deer, leg portions
Animal processing	Faunal (Chapter 6)	More intensive marrow and bone grease rendering, less intensive roasting	More intensive roasting, less emphasis on bone marrow extraction and bone grease rendering

for rapid heating, allowing liquids to come to a boil quickly, and facilitating easy access to vessel contents during cooking and/or serving. The conoidal vessels, requiring placement directly in and/or over fire or coals, are designed for lower temperatures and longer duration cooking such as simmering or stewing. As with the globular jars, the unrestricted orifices of the conoidal vessels allow for easy access during cooking and serving. The conoidal jars are typically medium/large sized and designed to cook a larger volume of food, or possibly for a larger sized social group. The neckless jar form, with thin walls, allows for rapid heating; its restricted orifice, although lessening heat loss, does not allow for easy manipulation of contents during cooking and/or serving.

Based on the assessment of intended function, Early and Middle Woodland vessels were designed to be used in different ways. Based on vessel form, the Early Woodland vessels are smaller in size and designed for rapid heating or boiling with easy access to the pot during cooking or serving. Middle Woodland vessels exhibit more varied forms and are typically larger, conoidal shaped vessels designed for longer term heating at lower temperatures with easy access to vessel contents. One small neckless jar, associated with the Middle Woodland component, is designed for rapid heating but not easy access.

Hearth form is inferred from both vessel form as well as evidence of actual use, based on exterior soot patterns. Using vessel form, conoidal, sub-conodial, and neckless jars were likely designed to be placed in or over a fire or coals, supported by some other technology. Globular jars, having more stability, allowed placement directly in/on a fire and/or coals without supports. The differential patterning of exterior soot on Early and Middle Woodland vessels indicates different techniques for positioning in, on, and/or over the fire. Early Woodland vessels were likely placed in or over a fire whereas the Middle Woodland vessels were likely placed over coals. This observation is consistent with results of intended function, finding an association of Early Woodland jars with globular forms, designed for rapid heating. Middle Woodland vessels are more associated with conoidal forms, implicating longer term cooking with low heat, such as would be generated by coals.

Cooking type and mode associated with the Early and Middle Woodland components are inferred from use alteration traces. Early and Middle Woodland vessels exhibit distinct patterns of exterior sooting and internal carbonization that link to specific cooking types and modes. Early Woodland vessels exhibit a higher frequency of exterior sooting compared to Middle Woodland pots; sooting on Early Woodland vessels typically occurs on the upper and mid-body vessel portions. Middle Woodland vessels tend to have sooting on the exterior rim and lip, consistent with placement over coals, with charring caused by spillovers and/or splatter. Early Woodland vessels exhibit interior carbonization patches on the vessel body (INT-2) and the body/rim (INT-4). Middle Woodland interior carbonization patterning consists mostly of an interior carbonization band (water or scum line) (INT-1) and patches on the body (INT-2). Simultaneously examining the patterning of exterior sooting and interior carbonization, through multiple correspondence analysis, identifies the Middle Woodland pots as having been heavily used for direct, wet mode cooking, such as stewing or boiling (Group I vessels). Early Woodland pots are more closely aligned with light to heavy use, direct, dry mode (roasting) and/or wet mode (simmering/stewing) (Group II) as well as some vessels associated with frequent use and/or indirect cooking (Group III).

The plant macroremains and zooarchaeological assemblages inform about specific processing activities represented in the assemblages using wood charcoal patterning, butchery patterns, burned bone frequencies and characteristics, and fragmentation ratios. Processing techniques are gleaned from the plant and animal data by evaluating: (1) evidence for roasting, bone marrow extraction, and bone grease rendering; (2) intensity and frequency of activities involving fire; and (3) preferred types and portions of animals.

Burning activities involving wood charcoal were more intensive and frequent for the Middle Woodland occupation compared to the Early Woodland component. Wood charcoal density and ubiquity measures indicate greater intensity and frequency of wood use, and/or activities involving fire, associated with the Middle Woodland component. Although the differences between Early and Middle Woodland wood abundance is not statistically significant, the relative frequencies and ubiquity measures suggest a greater frequency of site occupation associated with the Middle Woodland component, and/or that the site was visited for longer periods of time. There is some evidence for the latter based on the seasonality data. The Early Woodland occupation of the Finch site occurred in the fall and may have extended into the winter. The Middle Woodland occupation may have begun in the late spring and extended into the fall. The differences in wood charcoal use may also reflect the types of resources that were being processed as well as the amounts and intensity of processing. Black walnuts and acorns are associated with the Early Woodland component; these nuts types may have been processed via hand picking, for black walnut and boiling, for acorns (Swanton 1946; Talalay et al. 1994). Acorn, hickory, and hazel nuts are associated with the Middle Woodland component; processing activities for these nut resources could involve hand picking (hazelnut), boiling (acorn), and simmering (hickory nuts) (Swanton 1946; Talalay et al. 1994).

In contrast to the wood charcoal patterning, relative frequencies of burned bone are similar for the Early and Middle Woodland components. Examining the burned bone color patterning, both components exhibit very high frequencies of fully calcined bone.

The Finch site produced data regarding butchery patterns and preferred portion with no observed differences between the Early and Middle Woodland components. For both the Early and Middle Woodland assemblages, the cut marked bone represents medium/large mammals, with some specimens identified as white-tailed deer (*Odocoileus virginianus*). Of the cut marked bone identified to element, all represent the lower leg portions of the mammal.

Roasting, bone marrow extraction, and/or bone grease rendering is differentiated based on fragmentation ratios as well as the relative frequencies of single versus multiple colored burned bone. The Early Woodland and Middle Woodland data indicate only slightly higher relative frequencies of single colored burned bone as compared to bone burned to a multiple colors, indicating that bone marrow, grease rendering, and roasting activities are represented by both the Early and Middle Woodland assemblages. However, based on the relative frequencies of multiple color burned bone, more intensive roasting activities are associated with the Middle

Woodland component as compared to the Early Woodland. Moreover, the Early Woodland faunal assemblage is more fragmented that the Middle Woodland assemblage, further suggesting the greater representation of marrow and bone grease activities, rather than roasting, associated with the Early Woodland as compared to the Middle Woodland occupation.

Using the multiple lines of evidence from the Finch site reveals that there are some differences in the processing techniques represented by the Early and Middle Woodland assemblages (Table 7.4). The Early Woodland data indicate small vessels were used for rapid heating and boiling that allowed easy access to vessel contents. Some vessels were placed in or over a fire for roasting, simmering, and/or stewing and other vessels may have been used for indirect heating. Animals were processed using roasting as well as for marrow extraction and bone grease rendering. Marrow extraction and bone grease rendering were more prevalent for the Early Woodland component compared to the Middle Woodland component. The chemical residue profile of an IOCM vessel (vessel 3022) indicating the presence solely of herbivore, derived from a cooking pit that yielded only animal remains, provides good evidence of such marrow extraction/bone grease rendering activities associated with the Early Woodland occupation.

Associated with the Middle Woodland component are medium/large vessels used for long term simmering that allowed easy access to the contents during cooking. Some vessels were smaller, designed for rapid heating and little attending during cooking. Cookpots, heavily used, were placed in or over coals for boiling or stewing. Based on the chemical residue profiles, both herbivores and plants were prepared in the cookpots. Moreover, one Middle Woodland vessel (Shorewood Cord-Roughened vessel 2017) produced a lipid signature of decomposed nut oil as well as animal product, indicating that nuts were processed/prepared in the pots. Pouring and/or serving of the vessel contents often resulted in splattering, allowing food to adhere to lip/rim and char. Animals were processed using roasting as well as for marrow extraction and bone grease rendering. Roasting is more prevalent in the Middle Woodland as compared to the Early Woodland. Although these differences in processing techniques are notable, the leg portions of medium/large mammals, including white-tailed deer, are associated with both components.

The differences in processing activities may partially relate to the types of plant and animal resources that were being used. The ceramic use wear and lipid residue profiles indicate that vessels, for both components, were used for multiple purposes with activities involving a variety of plant and animal types. However, the different vessel forms may have been better suited for different types of tasks. The smaller, globular pots would have been better used for boiling activities, such as what would be needed to process acorns to remove the tannin (Swanton 1946; Talalay et al. 1984). The conoidal pots, designed for longer term simmering activities would have been better suited for nut oil extraction (such as for hickory nut oil) as well as for bone grease rendering. As acorns are associated with both components, the occurrence of globular vessels in both Early and Middle Woodland assemblages is not too surprising. Bone grease rendering would have been most effective in the conoidal shaped pots that are present in both the Early and Middle Woodland assemblage. The conoidal pots would also have been well-suited for nut oil extraction; hickory nutshell is only associated with the Middle Woodland component, suggesting that the conoidal pots were used in the Middle Woodland for nut oil extraction (hickory) as well as bone grease. The greater relative frequency of conoidal vessels in the Middle Woodland component as well as the evidence suggesting an increased reliance on nuts associated with Middle Woodland further supports this observation. The lipid results confirm that at least one Middle Woodland jar was used for nut oil processing.

Hypothesis 1 Discussion

Hypothesis 1 tests whether or not there are significant differences in the culinary traditions and foodways of the Early and Middle Woodland occupations. Two research questions relate to Hypothesis 1 examining for substantial differences in ingredients (Research Question 1) and processing/cooking techniques (Research Question 2) (Figure 7.4). Based on the Finch site data, the plant macroremains, zooarchaeological assemblage, and chemical residue analyses indicate little overall difference in ingredients between the Early and Middle Woodland components. Both the Early and Middle Woodland site occupations reflect heavy use of nuts and medium/large mammals, especially white-tailed deer. Both Early and Middle Woodland occupations potentially share a preference for leg portions of medium/large mammals, including white-tailed deer. Nuts were important for both components but may have been slightly more so for the Middle Woodland. Minor differences between the components relate to the type of nutshell harvested, with Early Woodland emphasizing more black walnut and Middle Woodland more hickory nutshell. Domesticates, consisting of squash (*Cucurbita* sp.), were associated with both the Early and Middle Woodland components; the Middle Woodland assemblage further yielded evidence of tobacco (*Nicotiana* sp.).

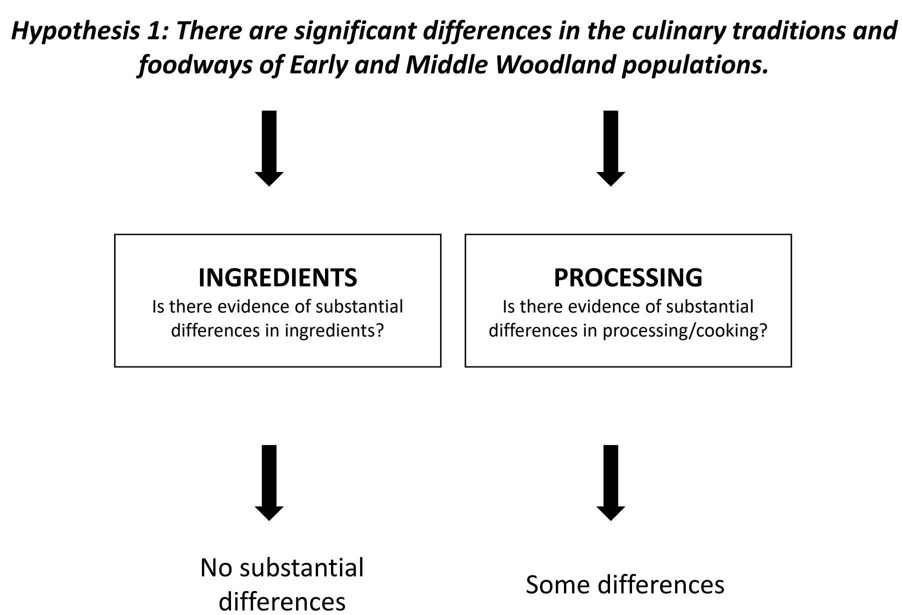


Figure 7.4. Hypothesis 1 summary of results.

Although ingredients remain largely unchanged, there is evidence for differential processing techniques of the Early and Middle Woodland occupations. Early Woodland cooking consisted of roasting, simmering, and stewing, with small vessels typically placed on or over a fire. However, some Early Woodland cooking vessels may have involved an indirect method. Contents could be easily manipulated during the cooking process. Middle Woodland cooking involved larger vessels placed on or over coals that were used for longer term simmering. A shift in processing has been noted in the Middle Woodland of west-central Illinois where it marks the beginning of an increasing importance of boiling starchy seed foods, resulting in a soft, palatable and digestible weaning food; the shift in processing is further implicated as triggering fertility rate increases, leading to population growth during the Late Woodland and Mississippian periods (Braun 1987; Buikstra et al. 1986; Cook and Buikstra 1979). Vessel contents could be easily manipulated during the cooking process. The vessels were filled near to the top and the contents may have been poured out during serving. The processing of medium/large mammals, through roasting, bone marrow extraction, and bone grease rendering, were important to both the Early and Middle Woodland site occupants. Comparatively, the Early Woodland processing consisted of more intensive marrow and bone grease rendering and less intensive roasting; the Middle Woodland processing involved more intensive roasting and less intensive marrow and bone grease rendering.

The Finch site Middle Woodland data indicates similar ingredients as compared to the Early Woodland, indicating a conservatism in social lifeways. Elsewhere in the Midwest and western Great Lakes, the Early to Middle Woodland denotes a transitional period of time that is associated with a increasing commitment to food production and cultivation of seed plants (Gremillion 2003; Simon and Parker 2006). In a broad Midwestern perspective, food patterns of Early Woodland populations were generally similar to the Late Archaic, with a heavy reliance on nutshell gathering as well as the hunting of medium/large mammals and fishing. Eastern Agricultural Complex (sumpweed, sunflower, and goosefoot), starchy seed plants (knotweed, little barley, maygrass, barnyard grass), and limited amounts of squash rind have been recovered from some Midwestern Early Woodland sites (Simon and Parker 2006). For the Middle Woodland component, a shift to greater reliance on food production occurs, indicated by greater representation of cultivated seed plants including spring and fall maturing starchy grain grasses (little barley, maygrass, goosefoot, and knotweed) and fall maturing oily seeded plants (sunflower, squash, and marshelder) (Simon and Parker 2006). Maize macroremains from Middle Woodland contexts are known from the Icehouse Bottom site in Tennessee and the Edwin Harness site in Ohio. In western Illinois and the American Bottom, there is some indication for the early appearance of maize; however, it is not considered an important cultivated crop plant until AD 900 (Simon 2017). Maize microremains, phytoliths or starch grains, have been dated to as early as 200 to 300 BC in New York State and to the first centuries AD from sites in Michigan, New York, and Ontario (Hart 2008; Hart et al. 2007; Hart and Lovis 2013; Hart et al. 2003; Raviele 2011; St-Pierre and Thompson 2015; Thompson et al. 2004, Simon 2017).

This broadly recognized trend, along with the occurrence of larger village sites, many with deep deposits in riverine settings, suggests a shift in plant and animal resource utilization during the Middle Woodland to include seed cultivation (Goldstein 1992). However, the southeastern Wisconsin data, based on the Finch site, indicate reliance on wild plant and animal resources, especially nuts and white-tailed deer, for both Early and Middle Woodland populations. The plant and animal data from the Finch site aligns with evidence regarding foodways from other southeastern Wisconsin sites. Plant and animal remains have been reported from a small number of Early Woodland sites, and even fewer sites yielded these organics from feature contexts (Haas 2019; Jones et al. 2015; Rusch 1988; Salkin 1986, 1989; Spector 1970). The limited data set suggests a continuation of Late Archaic subsistence practices (Salkin 1986; Stevenson et al. 1997). The Early Woodland data set indicates a reliance on medium/large mammals, especially white-tailed deer, and nutshell (acorn, hickory, walnut, and black walnut). Smaller mammals, turtle, bird, and fish, as well as squash rind and wild seeds have been recovered from Early Woodland sites in southeastern Wisconsin. The Bachmann site, a winter camp where intensive processing of white-tailed deer occurred, provides the only evidence of seed cultivation, yielding domesticated *Iva annua* var. *marcracarpa* (sumpweed) and *Helianthus annus* (sunflower) (Rusch 1988; Zalucha).

Subsistence activities of Middle Woodland peoples in southeastern Wisconsin involved a moderate to heavy emphasis on mammal and turtle resources with marginal exploitation of bird, fish and mussels (Lippold 1973; Salzer 1965, n.d., 1986). At Highsmith and Cooper's Shores, hunting and shellfish gathering are well-represented in the faunal assemblage (Stevenson et al. 1997). The absence of grinding stones, fishhooks, and processing features (roasting pits) at Highsmith and Cooper's Shores led Salzer (n.d., 1965) to note that there was little evidence for wild plant food collecting and intensive fishing. Faunal remains from the Cooper's Shores site reveal a predominance of deer, which appear to have been butchered off site with only the legs and head returned to the residential base (Benchley et al. 1997; Lippold 1973). The assemblage also included lower frequencies of elk, bison, beaver, muskrat, raccoon, domestic dog, wolf, bear, puma, and other small mammals, as well as fish, turtles, and mussels (Lippold 1971, 1973).

The southeastern Wisconsin patterns differs from southwestern Wisconsin where archaeological data indicates a shift in resource exploitation and subsistence from the Archaic to the Woodland tradition. Based on excavations at the Mill Pond site, there is a marked increase in freshwater mussel utilization during the Early Woodland (Theler and Boszhardt 2003:104-105). The Middle Woodland marks the first appearance of domestic plants and storage features, as well as the first house and multi-house communities (Freeman 1969; Stevenson et al. 1997). Horticultural economies emerge by the Middle Woodland period (circa AD 200) as evidenced by seed crops including sumpweed (*Iva annua*) and squash (*Curcurbita* sp.) (Arzigian 1987). Also represented at Middle Woodland sites in southwestern Wisconsin are nutshell, starchy seeds (goosefoot, knotweed), the initial appearance of wild rice, and various fruit, berry, and weed seeds (Arzigian 1987).

Despite the lack of evidence for a differences in ingredients, the Finch site data indicate shifts in processing techniques between the Early and Middle Woodland components. This difference is most pronounced with regard to the ceramic vessel data that show Early and Middle Woodland vessels were not only designed to be used differently, but were actually used for distinctive cooking techniques. Although ingredients remained largely unchanged, the Middle Woodland witnesses a new ways of cooking. The association of the Middle Woodland with larger pots and evidence of vessel contents being poured out is intriguing, potentially evidencing larger social groups. Other aspects of processing also shifted, although perhaps more subtly. Animal processing of both components involved roasting, bone grease, and bone marrow rendering. However, roasting was more intensive in the Middle Woodland component and bone grease/marrow rendering was more important in the Early Woodland occupation.

The significance of a difference in processing without a corresponding change in ingredients is not fully understood, nor can be fully addressed, using the data from a single site. There are several factors, however, that could account for this pattern. The Middle Woodland occupation may represent a more intensive occupation, resulting in the higher frequencies of burning and corresponding shifts in processing. The different nut taxa (i.e. black walnut, acorn, hickory) have different processing requirements. Finally, it is also possible that taphonomy plays a role, so that, in fact, new ingredients correlate with changes in the processing ways, but are not being preserved in the archaeological record. The chemical residue analysis, in part, supports this notion as the analysis identified the presence of plant roots, low fat content plants (such as fruits), and medium fat content foods (such as fish) in some vessels that are not represented, or very poorly represented, in the plant macroremain and faunal assemblages. Chemical residue and micro-botanical analyses can direct future studies to further explore this question.

The Finch site data do not indicate major differences in ingredients between the Early and Middle Woodland occupations but do reveal a shift in processing techniques (Figure 7.4). Given the persistence of ingredients, despite some differences in processing, Hypothesis 1 is rejected, and the null hypothesis, that the study of culinary traditions and foodways reveals no significant differences between Early and Middle Woodland groups, is accepted, with some important caveats.

The research design (Chapter 2) accepted the current cultural-historical paradigm with regard to key factors: (1) there is sequential temporal ordering of the Early and Middle Woodland stages in southeastern Wisconsin; and (2) there is an intensification of interaction with Havana-Hopewell during the Middle Woodland. The Finch site data reveal some limitations of the current cultural-historical framework that masks the social complexities of the time period recognized archaeologically as Early and Middle Woodland.

The AMS dates derived from the Finch site, and the review of the extant radiocarbon record for southeastern Wisconsin, reveals a temporal overlap between Early Woodland and Middle Woodland, indicating a period of dynamic social changes. Despite the limitations of the record, including the overall lack of direct dates on diagnostic artifact forms, both IOCM wares and Middle Woodland pots were manufactured from circa 100 BC to AD 100 in southeastern Wisconsin. The co-occurrence of Early and Middle Woodland ceramic forms in southeastern Wisconsin mirrors southwestern Wisconsin, where Prairie ware and Middle Woodland forms have been recovered from the same co-eval contexts (Johansen et al. 1998; Stoltman 2005). Although resolving the Early and Middle Woodland taxonomic sequence of southeastern Wisconsin is beyond the scope of this dissertation project, the data generated by the project directly addresses both the existing cultural-historical paradigm as well as evaluating the utility of such taxonomic structuring (Green 1999; Stoltman et al. 1978).

The Finch site data further call into question the accepted paradigm of an intensification of interaction during the Middle Woodland as compared to the Early Woodland. Both the Early and Middle Woodland components relied heavily on locally available Galena chert, with predominant non-local raw materials sourced from west-central Illinois and southeastern Iowa (Burlington chert). Based solely on lithic raw material profiles, there appears to have been persistent contact with more southerly groups (and groups in other regions) beginning during the Early Woodland and continuing into the Middle Woodland. Interactions with Havana extending into the Early Woodland are known for the Great Lakes (Indiana and Michigan), where Havana traits appear between 150 BC to AD 300 (Chivis 2016). Even further to the east, extensive inter-regional exchange is documented for the Early Woodland as evidenced by the recovery of domesticated chenopodium in southern Ontario, its presence interpreted as an exotic perishable food that was exchanged (Crawford et al. 2019). The social complexities of the Early and Middle Woodland stages is also noted in the west, where chronologies and ceramic stylistic data challenge long held migration models and further underscore the importance of cultural influences from multiple sources in addition to Illinois Havana-Hopwell (Keehner and Adair 2019).

Collectively, the Finch site culinary traditions and foodways do not reflect a substantial transformation or differences in the Early and Middle Woodland social realms. Rather, the data reveal similar lifeways using the same types of ingredients, with most used in similar ways. The data also reveal some differences with regard to how these same ingredients were cooked and shifting preferences of animal processing. What is not evidenced is a radical transformation, akin to the processes observed in the American Bottom, where interaction with Havana-Hopewell coincided with the appearance of domesticated maize and tobacco along with the increased use of starchy seeds, squash, and a preference shift from hickory to hazelnuts (Fortier 2006).

More locally, the culinary traditions and foodways expressed in southeastern Wisconsin are distinct from those in southwestern Wisconsin. Middle Woodland sites in southwestern Wisconsin correlate with the emergence of horticulture economies, mirroring the broader subsistence trends of the Midwest. In the middle to later portions of the Middle Woodland period, foodways dramatically change in southwestern Wisconsin. Cultigens appear in the archaeological record, indicating a increased reliance on seed crops that are being actively maintained and tended. These plants include squash, goosefoot (*Chenopodium* sp.), sumpweed/marshelder (*Iva annua*), knotweed (*Polygonoum* sp.), sunflower (*Helianthus annuss*), and little barley (*Hordeum pusillum*). Although not a cultigen, wild rice (*Zizania* sp.) also appears in the archaeological record at this time. Elsewhere in the Midwest, goosefoot (*Chenopodium* sp), marshelder (*Iva annua*), and sunflower (*Helianthus annus*), or Eastern Agricultural Complex plants, were brought under cultivation by 3000 to 4000 BC (Smith and Cowan 2003; Gremillion 2003). In addition to these Eastern Agricultural Complex plants, little barley, as well as ragweed and barnyard grass, are known to have been deliberately harvested by the Late Archaic in the American Bottom (Simon and Parker 2006). The presence of spring maturing starch grain grasses (little barley) and fall maturing seed and oily plants (goosefoot, knotweed, sunflower, squash, and marshelder) in southwestern Wisconsin reflects a shift to a greater role of food production and the beginning of a trend of increasing reliance on seed crops. It is suspected that the change in Middle Woodland ceramic vessel form, from Havana to Linn wares, is closely linked to this dramatic change in foodways.

When comparing the Middle Woodland foodways of southeastern and southwestern Wisconsin, a possible connection is evident between differences in foodways and degree of influence from Havana-Hopewell. Researchers have long noted that the southeastern Wisconsin data, especially with regard to mortuary patterns and grave goods, are much less attenuated as compared to southwestern Wisconsin; grave goods in southeastern Wisconsin Middle Woodland mounds are sparse, and pale in comparison to, southwestern Wisconsin (Stevenson et al. 1997; Struever 1965). Additional research comparing culinary traditions, foodways, and Havana-Hopewell interaction between southeastern and southwestern Wisconsin may further elucidate processes of community and identity formation.

The culinary traditions and foodways evidenced at the Finch site indicates that, although groups in southeastern Wisconsin were influenced by the Hopewell phenomena, such involvement did not result in a radical transformation of the social realm. In this manner, taxonomic placement of southeastern Wisconsin as a regional variant of Havana-Hopewell requires reconsideration. Southeastern Wisconsin may effectively mark a boundary for the extent of the Hopewellian phenomenon. Moreover, the conservatism in the social lifeways of southeastern Wisconsin, through a period of time that witnessed technological transformations, has the potential to further elucidate those mechanisms, unique to the local historical context and social processes, that resulted in such stability.

Hypothesis 2: Increased interaction with Havana-Hopewell precipitated the development of indicators of a stronger sense of community identity.

Hypothesis 2 tests for key indicators of community identity evidenced in the Finch site Early and Middle Woodland occupations and then evaluates whether a stronger sense of community identity is associated with the Middle Woodland component (Figure 7.5). Based on the current understanding of Havana-Hopewell, as well as the cultural-historical frameworks and political/ economic models regarding the Middle Woodland stage in southeastern Wisconsin, there is the expectation for the distinctive differences in community identity of Early Woodland and Middle Woodland groups. This dissertation project uses three criteria to evaluate for community identity and to assess for a strengthening of identity: the occurrence of more standardized cookpots and

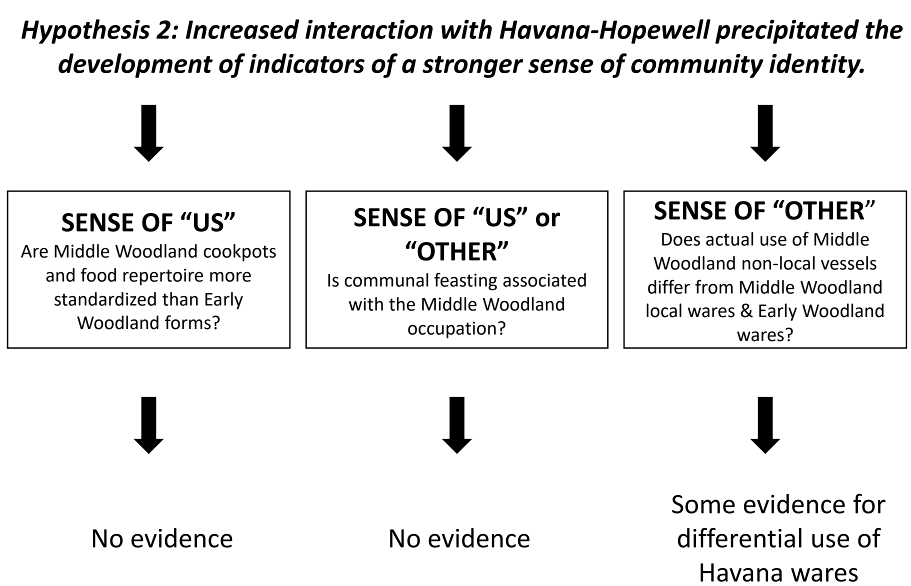


Figure 7.5. Hypothesis 2 summary of results.

foodways, evidence of communal feasting, and differential use of non-local vessels. Three research questions test Hypothesis 1 using the Finch site archaeological data.

Research Question 3: Are Middle Woodland cookpots and foodways more standardized than Early Woodland forms?

Processes that serve to de-emphasize social difference and individual status are archaeological indicators of community identity formation, recognized by the homogenization in type and form of material objects (MacSweeney 2011). This increased consistency in the ways of doing everyday things (Hegmon 1992) is manifest in the standardization of technical choices and artifact form, actively creating a stronger sense of "us" (MacSweeney 2011). Relative to culinary traditions and foodways, increased homogenization may manifest as decreased variability in the cookpot form and use, as well as less diversity of plant and animal taxonomic representation.

Two data sets from the Finch site are used to answer Research Question 3. The ceramic assemblage is evaluated using attribute data relating to vessel morphology, manufacture, and decoration to assess the range of variation (number of types) associated with the Early and Middle Woodland vessels. Increased standardization correlates with a decrease in the range of variation. Assessment of the standardization of foodways is evaluated from the plant macroremains and zooarchaeological assemblage using diversity indices.

The ceramic data provide little data to support the increased standardization of Middle Woodland vessels as compared to the Early Woodland vessels. Overall, only two aspects of the Middle Woodland assemblage exhibit a decrease in the range of variation, as compared to the Early Woodland pots, consisting of rim shape and wall thickness (Table 7.5). A total of five rim shapes are expressed in the Early and Middle Woodland vessels assemblage consisting of pinched, thickened, thickened and folded, folded, and unmodified forms. Each of these types are present in the Early Woodland vessel assemblage. Middle Woodland vessels exhibit three types of rim shapes including pinched, folded, and unmodified forms. Middle Woodland vessels have a narrower range

Table 7.5. Range of Variation of Ceramic Vessel Attributes Expressed by the Early and Middle Woodland Vessels.

	Total Number of Types: Early and Middle Woodland Vessel Assemablge	Number of Types: Early Woodland Vessels	Number of Types: Middle Woodland Vessels
Vessel Morphology			
Jar Form	4	2	4
Rim Stance	5	3	5
Rim Shape	5	5	3
Lip Form	3	3	3
Vessel Size	3	3	3
Vessel Wall Thickness	2	2	2
Vessel Manufacture			
Paste Core	7	7	7
Compactness	2	2	2
Fracturing			
Temper	5	4	4
Exterior Surface	4	2	4
Interior Surface	3	2	3
Vessel Decoration			
Overall	10	9	10
Location	3	3	3
Lip Decoration	4	3	4
Body decoration	9	5	8

of wall thicknesses as compared to the Early Woodland vessels, suggesting manufacturing of a more uniform thickness. All other morphological, manufacturing, and decoration aspects indicate that there is no change in the number of types or that the number of types increases.

The Finch site plant and animal assemblages indicate an increase in diversity of taxa associated with the Middle Woodland component as compared to the Early Woodland. As presented above, the Early Woodland and Middle Woodland assemblages are similar in terms of overall plant and animal composition. Changes in diversity between the Early and Middle Woodland assemblages are evaluated through the measuring of richness and equitability (evenness). The diversity measurements indicate that, relative to the Early Woodland assemblages, Middle Woodland plant and animal assemblages are richer and plant taxa exhibit more species diversity. Animal species diversity is relatively similar for the Early Woodland and Middle Woodland assemblages, with Early Woodland values just slightly higher than those values for the Middle Woodland. The plant and animal taxa in both the Early and Middle Woodland assemblages trend towards more even distributions. The Middle Woodland plant taxa are slightly more even than the Early Woodland plant assemblages. The Middle Woodland animal taxa are slightly less even as compared to the Early Woodland animal assemblages.

Research Question 4: Is communal feasting associated with the Middle Woodland occupation?

Archaeological indicators for feasting may include the presence of rare or labor intensive plant or animal taxa, signs of wasting food, and/or the presence of exceptionally large quantities of food or food refuse (Hastorf and Weismantel 2007; Hayden 2001; VanDerwarker and Idol 2008). The use of specific ingredients may be indicated by their rarity within refuse pits or in depositional histories (Hastorf and Weismantel 2007). The juxtaposition of butchery, refuse disposal, and contextual evidence also distinguishes patterns typical of quotidian household meals versus communal ritual feasts (Clifford-Gonzalez and Sunseri 2007; McKusick 1981; Potter 1997; VanDerwarker et al. 2016). Larger vessel sizes may provide further evidence of communal feasting (Johnson 2002; Tainter 1983)

The assessment of exceptionally high and/or low quantities of plant and/or animal remains is limited to nutshell and mammal remains, given the low sitewide representation of identified bird, fish, and reptile remains from the site, as well as the few seeds and squash. The ratio of total nutshell count to total plant weight by feature context does not indicate statistically significant differences in nutshell abundance between Early and Middle Woodland features, nor identifies any relevant outliers. Comparison of animal abundance focuses on the mammal remains, given the relatively low amounts of identified bird, fish, and reptile remains from the site. The data reveal similar ranges for the mammals count and weight ranges from Early and Middle Woodland features and do not indicate any statistically signficant differences. As such, there is no evidence of exceptionally low values of nutshell or mammals in features associated with either the Early or Middle Woodland component.

Examining the ceramic vessel data, Middle Woodland vessels tend to be bigger, but do not exhibit a statistically significant difference from the Early Woodland pots. Based on the ceramic functional analysis, there is a connection between jar form shape, wall thickness, and vessel size, suggesting that the larger Middle Woodland vessels were designed for cooking activities different than the thinner walled, smaller, globular vessels typical of the Early Woodland assemblage. Multiple correspondence analysis further indicated that the larger, thick-walled conoidal vessels are more closely associated with the Middle Woodland component while the smaller, thinner globular forms relate closer to the Early Woodland. These data suggest that the larger Middle Woodland conoidal vessels were designed to cook a larger volume of food and/or to serve a larger sized social group.

The descriptive statistics of vessel size, based on orifice diameter, indicates that the Early Woodland vessels have thinner walls on average and exhibit a more narrow range of diameters as compared with the Middle Woodland vessels. All Early Woodland vessels fall into the small, small/medium, and/or medium size categories, with no large Early Woodland vessels represented in the assemblage. Middle Woodland vessels include all four size categories. Based on relative frequencies, most Early and Middle Woodland vessels are small/medium sized. However, the Early Woodland assemblage has very few medium/large specimens sized specimens, while the Middle Woodland assemblage has higher relative frequencies of medium/large and large vessels.

Statistical analysis of vessel sizes does not indicate significant differences between the Early and Woodland vessel sizes. The notched box plots, although noting the larger range of variation of Middle Woodland vessels, overlap, indicating no statistically significant difference between the Early and Middle Woodland vessel orifice diameters (Table 5.10). Moreover, the Kruskal-Wallis test produced a p-value of 0.135, indicating that, based on orifice diameter, the Early and Middle Woodland vessels are derived from the same population (Table 5.14).

Research Question 5: Does the actual use of Middle Woodland non-local vessels differ significantly from the Middle Woodland local ware and Early Woodland ware use.

Based on patterns of exterior sooting and interior carbonization, vessels classified as Havana wares have a use distinct from the local Middle Woodland wares and Early Woodland pots. The chemical residue analysis; however, indicates that Early Woodland, local Middle Woodland, and Havana wares were generally used in similar ways for variety of food preparation and cooking involving herbivores and plant processing (Figure 7.6). Differences between the vessel types reveal the association of Early Woodland vessels with medium content foods (possibly fish), the local Middle Woodland vessels with nut oil, and the Havana ware with fattier herbivore meats and bone marrow.

Based on the multiple correspondence analysis using vessel groups (Early Woodland, local Middle Woodland, and Havana wares), exterior soot type, and interior carbonization pattern, Havana wares are most closely associated with Group I pots. Group I pots exhibit an interior carbonization band with exterior sooting on the rim and/or lip. Patchy sooting may also occur on the interior rim. Group I pots define heavily used, multi-functional forms that were employed for wet-mode cooking activities involving boiling and/or stewing. The presence of soot on the exterior lip and/or rim suggests that the vessel contents may have been poured out and/or frequently manipulated during cooking. The local Middle Woodland wares are more closely associated with Early Woodland forms than with the Havana wares. Early Woodland vessels are associated with Group II type cooking activities that involved light to heavy use for dry mode (roasting, simmering) and/or stewing tasks. The local Middle Woodland wares tend to be associated with Group III type vessels that lack a clear interpretation as to vessel function.

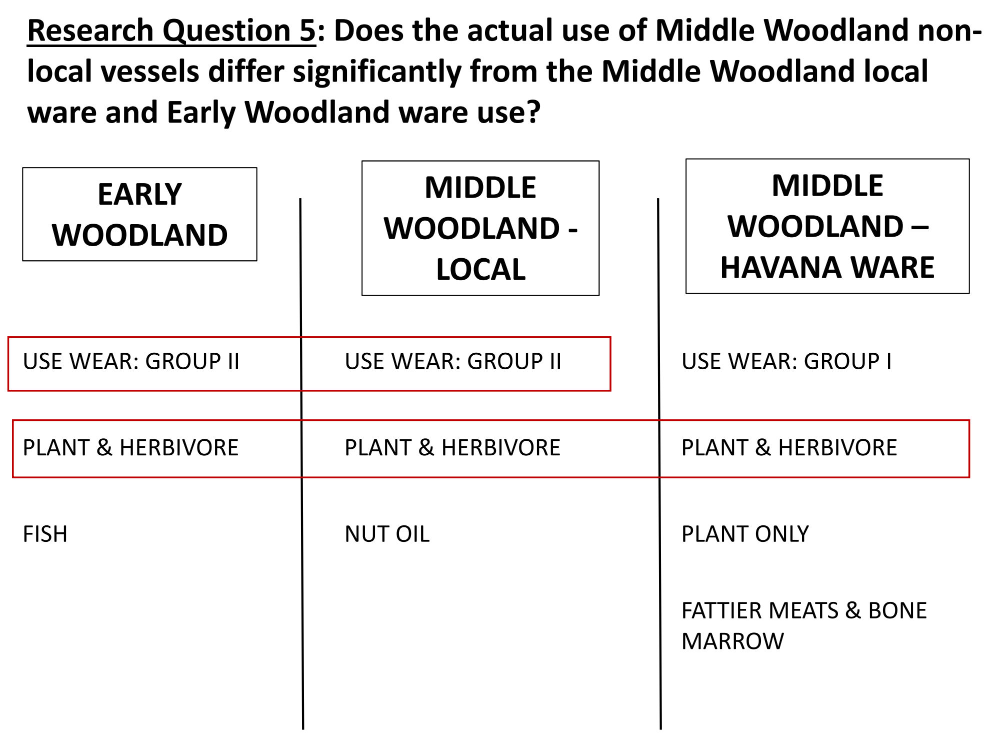


Figure 7.6. Summary of findings for Research Question 5.

The lipid residue analysis was conducted on 13 Early and Middle Woodland vessels. Overall, the lipid residue analysis suggests that Early Woodland, local Middle Woodland, and Havana wares were similarily used for variety of food preparation and cooking involving herbivores and plant processing. The residue analysis concords with the use wear analysis that concluded most Early and Middle Woodland pots were used for multiple functions with use intensity ranging from light to heavy. There is lack of clear differentiation, based on residue profiles, between the Early Woodland, local Middle Woodland, and Havana Middle Woodland vessels. Although, as noted above, and shown in Figure 7.6, there are some minor differences between the ware types. Future analyses can explore this trend to determine if these differences are significant.

Hypothesis 2 Discussion

Hypothesis 2 tests for the emergence of a stronger sense of community identity associated with the Middle Woodland following an intensification of interaction with Havana-Hopewell. Three research questions evaluate evidence indicative of a stronger sense of community identity: the occurrence of more standardized cookpots and foodways (Research Question 3), evidence of communal feasting (Research Question 4), and differential use of non-local vessels (Research Question 5).

The archaeological data used to answer Research Questions 4 and 5 reveal little evidence to support the presence of a stronger sense of community identity associated with the Middle Woodland occupation as compared to the Early Woodland component. Based on the ceramics, as well as the taxonomic representation of plant and animal species, there is little to no evidence of a more standardized "way of doing things" associated with the Middle Woodland component as compared to the Early Woodland occupation. Ceramic vessel attributes are generally characterized as highly variable for both components. Quantifying the number of variables expressed indicates that the number of expressions for each morphological trait remains constant or increases for the Middle Woodland pots, with few exceptions. Moreover, diversity indices reveal a slight increase in the plant diversity while animal diversity remains fairly constant. Evidence of feasting was also not identified at the Finch site for either the Early and/or Middle Woodland component. Statistical outliers (high or low) for the most common plant and animal species were not identified by the data. Middle Woodland pots, however, tend to be larger than Early Woodland vessels, although this difference is not statistically significant. The larger Middle Woodland vessels, likely not indicative of feasting given the lack of significant size difference, may indicate a different way of cooking and/or servicing a larger social group.

The only limited evidence to support a stronger sense of community identify is derived from the ceramic use alteration analysis used to answer Research Question 5. Based on patterns of exterior sooting and interior carbonization, vessels classified as Havana wares may have a use distinct from the local Middle Woodland wares and Early Woodland pots. The Havana ware pots are heavily used, multi-functional forms that were employed for wet-mode cooking activities involving boiling and/or stewing. The presence of soot on the exterior lip and/or rim suggests that the vessel contents may have been poured out and/or frequently manipulated during cooking. Even more intriguing is the chemical residue analysis from two vessels that further suggests Havana wares were used to cook fattier herbivore meats and bone marrow; these residue signatures are unique to the Havana ware vessels.

The Finch site data do not indicate the occurrence of a stronger sense of community identity associated with the Middle Woodland component. Based on the lack of evidence for an increased standardization of cookpots and foodways and/or feasting, Hypothesis 2 is rejected. The null hypothesis, that the development of a stronger sense of community identity did not emerge following an intensification of interaction with Havana-Hopewell is accepted, noting a few caveats described below. Moreover, based on the Finch site data, there is little evidence that southeastern Wisconsin groups became fully embedded within a broader Hopewellian relational or symbolic community (Ruby et al. 2006).

The Hopewell phenomenon has been modeled as a process of community identity transformation through the development of relational communities that may or may not be circumscribed by geographical space (Carr 2006; Ruby et al. 2006). This concept characterizes Hopewell as the concurrent representation of a locally interpreted, regionally varied phenomenon grounded in each region's unique historical context, and a supra-local phenomenon derived from practices/forms/symbols that are consistent across regions. The local/supra-local nature of Hopewell is also conceptualized as local, residential, and symbolic communities (Ruby et al. 2006).

The concept of local/residential, sustainable, and symbolic communities defines a process of group identity formation wherein individuals actively construct and negotiate group identity and affiliation (Ruby et al. 2006; Chivis 2016). Local communities are the spatially distinct clusters of residences with regular daily interaction whose members share a common identity and co-residence or close residence (Carr 2006; Chivis 2016; Ruby et al. 2006; Varien 1999). Sustainable communities network on a larger scale representing the spatial and demographic components necessary to maintain residential communities. Symbolic communities integrated residential communities into larger, more inclusive groups and were expressed in the cultural practice of monumentalism, reflective of a ceremonial context broader than solely funerary ritual (Buikstra et al. 1998; Charles et al. 2004; King et al. 2011).

The Hopewell phenomonena as reflective of community identity transformation, including the appearance of forms of a supra-local relational community (or symbolic communities), has been documented amongst peripheral Hopewellian groups in western Michigan and the American Bottom (Chivis 2016; Fortier 2006). In the American Bottom, the shift to Havana-Hopewell was dramatic, including changes in settlement type, ceramic style and technology, stone tool technology, and subsistence practices (Fortier 2006). Based on this evidence, characterized as a technological and horticultural revolution, Fortier (2006) argues that the American Bottom communities were leading towards the development of their own identity (Fortier 2006). In Michigan, interaction with Havana-Hopewell groups led to the formation of local and regional communities, new social/cultural identities distinct from local Early Woodland populations (Chivis 2016). Distinct residential communities were geographically circumscribed within specific river valleys, connected to each other as a sustainable community, and formed a relational identity, a symbolic community, expressed in the local interpretation and adoption of Havana and Hopewell designs (Chivis 2016).

The local processes at play in southeastern Wisconsin during the Early and Middle Woodland are different from those processes occurring elsewhere in the Hopewellian world. These local processes undergird the persistence and longevity of locally adapted lifeways and, in a sense, may have impeded the formation of "new" community identities despite interaction with Havana-Hopewellian groups. The archaeological data from the Finch site, and from other southeastern Wisconsin sites, offer some clues in understanding why southeastern Wisconsin groups did not become part of a Hopewellian community. First, the later Early Woodland in southeastern Wisconsin evidences well adapted populations with long standing connections to the landscape (Goldstein 1992; Jeske 2006) and the emergence of archaeologically recognizable regional "traditions" by the later portion of the Early Woodland. These distinctive regional populations of the later Early Woodland period are known from sites reported around Lake Waubesa, and likely around the wider Four-Lakes/Yahara River locale in and around Madison, around Lake Koshkonong, and inland from Lake Michigan (Jones et al. 2015; Rusch 1988; Salkin 1986; Salzer n.d., 1965). These populations followed a seasonal round, largely relying on stable, predictable resources focused on white-tailed deer and a variety of nuts.

Second, the Finch site data indicate persistent inter-regional contact with more southerly groups occurring during the Early Woodland, with little evidence for significant intensification during the Middle Woodland. Based on the Finch site raw materials, interaction with extra-regional groups occurred during the Early Woodland, and may have been established during the Archaic. Archaeological data from southwestern Wisconsin also evidences a long "persistent interaction" with extra-regional groups (Stoltman 2006).

At the Early Woodland Tillmont site (47CR0460) in southwestern Wisconsin, obsidian that was sourced to Obsidian Cliff, Wyoming, was identified in an Early Woodland context (Stoltman 2005). The presence of obisdian in an Early Woodland context, suggests that people affiliated with the Red Ocher/Marion culture were using obsidian by circa 500 BC, well before the onset of the Hopewell Interaction Sphere (Stoltman 2005:67; Stoltman and Hughes 2004). Moreover, Stoltman (2005) notes an early date of 785 to 411 BC procured from the leather cordage and bark in association with a large obsidian block, also sourced to Obsidian Cliff, from Riverside Cemetery (Pleger and Stoltman 2009). The Tillmont and Riverside site data suggest that Obsidian Cliff obsidian was procured and circulated by Early Woodland peoples several centuries before the appearance of the Hopewell Interaction Sphere, reflecting the deeply embedded roots of interaction networks in the local Early Woodland complexes of the Eastern Woodlands (Stoltman and Hughes 2004:758).

In southeastern Wisconsin, around Lake Waubesa, Salkin (1986) recognized stylistic similarities between Early Woodland Waubesa Incised vessels from the Beach site, along Lake Waubesa (Yahara River), and Fettie Incised ceramics, an early Havana ware type (Griffin 1952). The Early Woodland assemblage from Finch yielded exotic raw materials of Burlington chert and Wyandotte chert, indicating interaction with groups in Iowa, west-central Illinois, and Indiana.

The presence of well-adapted Early Woodland populations played a role in the unique historical processes of southeastern Wisconsin and are distinct from those events played out else where in the Hopewellian world. In the Lower Illinois River Valley, Hopewell origins are correlated with the physical migration of Havana groups from central Illinois into the Lower Illinois valley, a region largely devoid of populations during the Early Woodland (Charles 1992; King et al. 2011). The migration marked a major demographic reorganization of the social and natural landscape with settlements concentrated along the river valleys (Charles 1992). The Hopewell populations likely migrated due to environmental and/or social factors to the (largely vacant) frontier where they actively engaged in community formation and sustainability (Kopytoff 1987). Through an active process of social construction, leaders of these migrant groups manipulated mortuary ritual, exotic materials and finished goods, and symbols to simultaneously authenticate and elevate their own authority and integrate outside groups (Charles 1992).

Contemporary models associate the origins of Havana-Hopewell in western Michigan and northwestern Indiana as related to diffusion and the spread of ideological or information through interaction. The argument for diffusion is based on early Middle Woodland dates, evidence of Early Woodland occupations underlying Middle Woodland components, presence of very early Middle Woodland ceramic wares, and lack of sophistication in ceramic technology (Brashler et al. 2006; Chivis 2016; Kingsley 1999). Using cumulative radiocarbon dates, Chivis (2016) identifies three statistically distinct temporal periods in western Michigan and northwestern Indiana. The Early Communities date to 150 BC to AD 30 and mark the introduction of Havana into the region. The Middle Communities date to AD 30 to AD 250, corresponding with the late Norton and early to middle Converse Phases in west Michigan and the middle to late Goodall and early La Porte Phases in Indiana. The Transitional Communities date to AD 250 to 400, and relate to the late Converse Phase and the middle to late La Porte Phase (Chivis 2016). The statistically significant grouping of the AMS dates into three periods underscores that the spread of Havana-Hopewell information, ceramic styles, and technology occurred over a lengthy period of time and varied in intensities that are temporally and geographically distinct (Chivis 2016).

At the Finch site, the lack of evidence to suggest the emergence of a stronger sense of community identity, or the transformation of community identity, associated with the Middle Woodland occupation, the dissertation project identified some key differences between the Early and Middle Woodland occupations worth further consideration. Notably, the examination of actual use of ceramic vessels exposed some differences between Early Woodland wares, local Middle Woodland pots, and the non-local Havana ware vessels. The distinctive use wear pattern of the Havana ware pots potentially indicates a different way of cooking foods than the methods followed for the Early and Middle Woodland pots. Moreover, the limited chemical residue data further reveal that two of the Havana ware vessels are associated with fattier herbivore meats and bone marrow. Perhaps these vessels provide evidence of a discrete event involving Finch site inhabitants with Havana-Hopewell representatives, as food preparation and consumption often play a central part of ritual and social gatherings (Babcock 1990; Hastorf 2017; Hegmon 1989; Mobley Tanaka 1997; Palmer and Van der Veen 2002).

Equally intriguing is the likely occurrence of tobacco from a Middle Woodland pit feature (of an indeterminate function) at the Finch site. The Middle Woodland stage marks the first reported appearance of pipes from archaeological sites in Wisconsin (Sabo 2007; Stevenson et al. 1997). Curved and straight based platform type pipes are associated with Waukesha phase mortuary contexts in southeastern Wisconsin but are generally not recovered in domestic contexts (Salzer n.d.). However, at the Alberts site, surface collection of the fields east of the mounds yielded a fragment of a Hopewellian monitor pipe manufactured of Illinois pipestone (Jeske and Kaufman 2000). Tobacco has also been identified from Middle Woodland contexts in the Illinois River valley where it has been dated to circa 70 BC to AD 320 (Asch and Asch 1985). In Wisconsin, at the Bachmann site in eastern Wisconsin, two tobacco seeds may be associated with the late Early Woodland component, although derived from a mixed context (Rusch 1988).

Summary and Conclusions

This dissertation project used culinary traditions and foodways to examine evidence for substantial differences in community and community identity of groups occupying the western Great Lakes region from circa 100 BC to AD 400 (Table 7.6). Culinary traditions and foodways directly reflect community and community identity as the selection, preparation, and consumption of food serves to constitute and distinguish individuals as members of a cultural group. In this manner, foodways are viewed as condensed social facts that embody the dispositions and values of a group, active in all practices of identity formation. As learned, culturally patterned techniques of body comportment, foodways are expressive in a fundamental way of identity and difference, an integral part of the cultural fabric that is sensitive to changes in traditional practices.

Culinary traditions and foodways encompass multiple aspects of consumptive behavior inclusive of procurement, ingredients, as well as cooking/processing techniques. These consumptive practices are archaeologically accessible through multiple lines of material evidence. This study implemented a multi-proxy approach that integrates traditional plant macrobotanical studies, faunal analysis, ceramic morphological and use wear analyses, and absorbed chemical residue analyses to provide a comprehensive overview of culinary traditions and foodways. Archaeological studies of ceramic cookpots are complementary to the direct material evidence of plant macroremains and animal remains, and are closely connected to the role of food preparation and consumption, as the overwhelming primary function of vessels is the processing, storing, and/or transporting of food and liquids. This robust combination of analytic methods allows for a multi-faceted and comprehensive interpretation of the material data. Culinary traditions and foodways are delineated through ingredients and processing/cooking techniques. Aspects of community identity formation and cohesion are evaluated by examining evidence for a trend towards standardization in cookpot form and foodways, the presence of communal feasting, and differential uses of ceramic vessels ware types.

The Finch site, an open air Early to Middle Woodland (ca 100 BC to AD 400) era pre-contact American Indian habitation site located in the western Great Lakes region of North America provided a case study for examining changing culinary traditions and foodway traditions at the community level. This project investigated the connections between the concept of community (and community identity) and culinary repertoire and foodway traditions by examining for differences between the Early and Middle Woodland components at the site and elucidating the relationship of these differences to extra-regional interaction with new and culturally different social groups. A comparison of the Early and Middle Woodland components at the Finch site was expected to reveal substantive differences in culinary traditions and foodways, evidencing the emergence of a stronger sense of community identity or cohesion associated with the Middle Woodland occupation. Such differences were expected to occur as this period of time encompasses an intensification of interaction with Havana/Hopewell populations from outside the region.

Table 7.6. Summary of Results

Hypotheses and Research Questions	Summary of Results
Hypothesis 1: There are significant differences in the culinary traditions and foodways of Early and Middle Woodland populations.	
Research Question 1: Is there evidence of substantial differences in ingredients?	No Substantial Difference Early and Middle Woodland assemblages are similar and indicate a focus on nut resources and medium/large mammals, especially white-tailed deer. Chemical residues of Early and Middle Woodland vessels are broadly similar indicating the presence of herbivores and plant material
Research Question 2: Is there evidence of substantial differences in processing/cooking techniques?	Some Differences Early Woodland cooking involved roasting, simmering, and stewing with vessel on or over fire and contents easily manipulated; Intensive marrow and bone grease rendering of animal resources. Middle Woodland cooking placed larger vessels on or over coals for long term simmering with some vessels used for boiling. Vessels filled near to the top and contents poured out.; Intensive roasting activities and less intensive marrow and bone grease rendering of animal resources. Evidence for marrow extraction and bone grease rendering. Both Early and Middle Woodland assemblage share preference for leg portions of medium/large mammals, including white-tailed deer.
Hypothesis 2: Increased interaction with Havana-Hopewell precipitated the development of indicators of a stronger sense of community identity.	
Research Question 3: Are Middle Woodland cookpots and foodways more standardized than Early Woodland forms?	No Substantial Difference Ceramic vessels highly variable for both the Early and Middle Woodland components Plant diversity indices increase from Early to Middle Woodland and animal diversity remains constant
Research Question 4: Is communal feasting associated with the Middle Woodland occupation?	No Evidence No evidence of feasting was identified for either the Early or Middle Woodland component
Research Question 5: Does the actual use of Middle Woodland non-local vessels differ significantly from the Middle Woodland local ware and Early Woodland ware use?	No Substantial Difference Use alteration traces slightly different on the Havana Ware pots. Chemical residue signature similar for Early Woodland, local Middle Woodland, and Havana ware, indicating use for herbivores and plant.

This dissertation project has revealed that the Finch site culinary traditions and foodways do not reflect a substantial transformation of the social realm. Rather, the data reveal a persistence of lifeways using the same types of ingredients, with most used in similar ways. The data also reveal some differences with regard to how these same ingredients were cooked and shifting preferences of animal processing. The significance of minor changes in processing without a corresponding differences in ingredients is not fully understood, nor can be fully addressed, using the data from a single site. It is possible that the types of nut resources had different processing requirements and/or taphonomy played a role so that, in fact, new ingredients did accompany the change in the processing ways, but are not being preserved in the archaeological record. Chemical residue and micro-botanical analyses can direct future studies to explore this question.

The archaeological data also reveal little evidence to support the presence of a stronger sense of community identity associated with the Middle Woodland occupation at the Finch site. Cookpot form remains variable and foodways continue to involve similar wild plant and animal resources. The only evidence suggestive of a shift in community identity is derived from the ceramic use wear analysis that indicates Havana/Hopewell vessels were used in slightly different ways than the local Middle Woodland ware types and Early Woodland vessels.

Finally, if the Finch site data is typical of Middle Woodland groups in southeast Wisconsin, there is little evidence suggesting that groups in the region of became embedded within a broader Havana-Hopewellian relational or symbolic community. While the limited evidence for differential use of Havana pots and the presence of tobacco suggests peripheral participation, or at least knowledge of the Hopewell world, the Finch site data provides little evidence that southeastern Wisconsin groups became embedded within a broader Hopewellian relational or symbolic community (Ruby 2006). The local processes at play in southeastern Wisconsin during the Early and Middle Woodland are distinct from those processes occurring elsewhere in the Havana/Hopewellian world, likely a factor in the community identity formation and transformation (Jeske 2006).

The Finch site data reveal some limitation with the current cultural-historical framework that masks the social complexities of the time period recognized archaeologically as Early and Middle Woodland. The AMS dates derived from the Finch site, and the review of the extant radiocarbon record for southeastern Wisconsin, reveals a temporal overlap between late Early Woodland and Middle Woodland, indicating a gradual continuum rather than sequential social change. The Finch site data further call into question the accepted paradigm of an intensification of interaction during the Middle Woodland as compared to the Early Woodland. Both the Early and Middle Woodland components relied heavily on locally available Galena chert, but with non-local raw materials sourced from west-central Illinois and southeastern Iowa (Burlington chert). Based solely on lithic raw material profiles, there appears to have been persistent contact with more southerly groups beginning during the Early Woodland and continuing into the Middle Woodland. Although resolving the Early and Middle Woodland taxonomic sequence of southeastern Wisconsin is beyond the scope of this dissertation project, the data generated by the project directly addresses both the existing cultural-historical paradigm as well as evaluating the utility of of such taxonomic structuring. The southeastern Wisconsin data appears to parallel the late Early Woodland-Middle Woodland dynamics observed both in southwestern Wisconsin and northeastern Wisconsin, where late Early Woodland and Middle Woodland wares co-occur and are also co-eval (Mason 1966; Johnasen et al. 1998; Stoltman 1990, 2005, 2006). Given the overlapping dates, it is unlikely that the Middle Woodland presence in southeastern Wisconsin represents a physical migration of Havana peoples from the south (sensu Salkin 1986).

The project began with the premise that what is archaeologically recognized as Early and Middle Woodland can be conceptually viewed as potentially representative of distinct communities. The similarities of culinary traditions and foodways, along with the overlapping temporal associations, challenges this notion. Moreover, the lack of stronger indicators of community identity associated with the Middle Woodland component further underscores that what is archaeologically recognized as Early and Middle Woodland in southeast Wisconsin may simply be a lengthy adaptive continuum spanning the end of the Archaic to the beginning of Late Woodland. As the data for this project is derived from a single site, future research can further this discussion and elucidate the relationship between Early and Middle Woodland in southeastern Wisconsin.

In a regional perspective, the culinary traditions and foodways expressed in southeastern Wisconsin are distinct from those in southwestern Wisconsin. Middle Woodland sites in southwestern Wisconsin correlate with the emergence of horticultural economies, mirroring the broader subsistence trends of the Midwest. Most intriguing, when comparing the Middle Woodland foodways of southeastern and southwestern Wisconsin, a possible connection is evident between differences in foodways and degree of influence from Havana-Hopewell.

The Finch site data has revealed how aspects of community and community identity are reflected in culinary traditions and foodways that are archaeologically accessible using a multi-proxy approach. Plant macroremains, when integrated with faunal and ceramic analyses, and chemical residue studies, provides a robust accounting of ingredients and processing/activities, defining the culinary traditions and foodways of a community. The rich data set resulting from the complementary nature of these diverse methods reveals a wealth of data about consumptive practices and communities, underscoring the potential application of such an analytic approach to long standing problems in other archaeological contexts worldwide.

The Finch site is, of course, only one site among many contemporary sites and locales in southeast Wisconsin and it is unknown if the site is representative of the region as a whole or atypical. Consequently, results of the Finch site analysis will need to be corroborated by similar investigations at other contemporary sites in southeast Wisconsin before the model derived from the Finch data set can be widely applied. However, the Finch site model provides a testable framework with which to reevaluate the technological and social dynamics of an important but understudied portion of the pre-contact archaeological record in the southwest Lake Michigan basin.

REFERENCES CITED

Abrams, Elliot M.

2009 Hopewell archaeology : A View from the Northern Woodlands. J*ournal of Archaeological Research* 17:169-204.

Adams, Karen R. and Susan J. Smith

2011 Reconstructing Past Life-Ways with Plants I: Subsistence and Other Daily Needs. In *Ethnobiology*, edited by E. N. Anderson, D. Pearsall, E. Hunn and N. Turner, pp. 149-171. John Wiley & Sons.

Alberti, Gianmarco

2013 Making Sense of Contigency Tables in Archaeology: the Aid of Correspondence Analysis to Intra-Site Activity Areas Research. *Journal of Data Science* 11:479-499.

Amit, V. and N. Rapport

2002 *Realizing Community: Concepts, Social Relationships, and Sentiments*. Routledge, London.

Anderson, B.R.O.G.

2006 *Imagined Communities: Reflections of the Origin and Spread of Nationalism*. Verso, London.

Anderson, Shelby L., Shannon Tushingham, and Tammy Y Buonasera

2017 Aquatic Adaptations and the Adoption of Artic Pottery Technology: Results of Residue Analysis. *American Antiquity* 82(3):452-479.

Appadurai, A

1988 Introduction: Commodiities and the Politics of Value. In *The Social Life of Things: Commodities in Cultural Perspective*, edited by A. Appardurai, pp. 3-65. Cambridge University Press, Cambridge.

Atalay, S. and C. Hastorf

2006 Food, meals, and daily activities: Food habitus at Neolithic Çatalhöyuk. American Antiquity 71:283-319.

Arzigian, Constance M.

1987 The Emergence of Horticultural Economies in Southwestern Wisconsin. In *The Emergence of Horticultural Economies of the Eastern Woodlands*, edited by W. F. Keegan. vol. Occassional Publication 7. Center for Archaeological Investigations, Carbondale.

1993 *Analysis of Prehistoric Subsistence Strategies: A Case Study from Southeastern Wisconsin,* PhD Dissertation, Department of Anthropology, University of Wisconsin-Madison, Madison, Wisconsin.

2000 Middle Woodland and Oneota Contexts for Wild Rice Exploitation in Southwest Wisconsin. *Midcontinental Journal of Archaeology* 25(2):245-288.

Asch, David L. and Nancy B. Asch
1985 Prehistoric Plant Cultivation in West-Central Illinois. In *Anthropological Papers*, edited by R. I. Ford, pp. 149-204. vol. 75. Museum of Anthropology, University of Michigan, Ann Arbor.

Asch, Nancy B., Richard I. Ford and David L. Asch
1972 *Paleoethnobotany of the Koster Site: The Archaic Horizons*. Reports of Investigations 24. Illinois State Museum, Springfield.

Asmussen, Brit
2009 Intentional or Incidental Thermal Modification? Analyzing Site Occupation via Burned Bone. *Journal of Archaeological Science* 36(528-536).

Babcock, B.A
1990 At Home No Womens are Storytellers: Potteries, Stories and Politics in Cochiti Pueblo. *Journal of the Southwest* 32:356-389.

Baerreis, D.A.
1952 *Pottery Type Descriptions*. Paper presented at a conference of the Wisconsin Archaeological Survey, Madison, Wisconsin.

Bakken, Charlotte T.
1949 *Preliminary Investigations at the Outlet Site*. Master of Arts Thesis. Department of Anthropology, University of Wisconsin-Madison. Madison, Wisconsin.
1950 Preliminary Investigations at the Outlet Site. *The Wisconsin Archeologist* 31(43-70).

Bakken, K
1997 Lithic Raw Material Resources in Minnesota. The Minnesota Archaeologist 56:51-83.

Banducci, Laura M.
2014 Function and Use of Roman Pottery: A Quantitative Method for Assessing Use-Wear. *Journal of Mediterranean Archaeology* 27(2):187-210.

Barth, F. (Editor)
1969 *Ethnic Groups and Boundaries: The Social Organization of Culture Difference.* Little, Brown, Boston.

Baxter, Michael J.
1994 *Exploratory Multivariate Analysis in Archaeology*. Edinburgh University Press, Edinburgh.

Beck, Margaret E., James M Skibo, David J. Hally and Peter Yang
2002 Sample Selection for Ceramic Use-Alteration Analysis: the Effects of Abrasion on Soot. *Journal of Archaeological Science* 29:1-15.

Becker, George C.
1983 *Fishes of Wisconsin*. The University of Wisconsin Press, Madison, Wisconsin.

Beisaw, April M.
2013 *Identifying and Interpreting Animal Bone: A Manual*. Texas A&M University Anthropology Series, Texas.

Benchley, Elizabeth D., Blane Nansel, Clark A. Dobbs, Susan M. Thurston Myer, and Barbara H. O'Connell
1997 *Archeology and Bioarchaeology of the Northern Woodlands*. The Central and Northern Plains Archeological Overview. Arkansas Archaeological Survey, Fayetteville, Arkansas.

Bender, Margaret M., David A. Baerreis, Reid A. Bryson and Raymond L. Steventon
1982 University of Wisconsin Radiocarbon Dates XIX. *Radiocarbon* 1:83-100.

Bennett, Joanne L.
1999 Thermal Alteration of Buried Bone. *Journal of Archaeological Science* 26:1-8.

Bennett, John W.
1952 The Prehistory of the Northern Mississippi Valley. In *Archaeology of the Eastern United States*, edited by J. B. Griffin, pp. 108-123. University of Chicago Press, Chicago.

Berger, P.L. and T. Luckmann
1967 *The Social Construction of Reality: A Treatise in the Sociology of Knowledge*. Anchor Books, New York.

Berstan, Robert, AW Stott, S. Minnitt, C. Bronk Ramsey, REM Hedges and Richard P. Evershed
2008 Direct dating of pottery from its organic residues: new precision using compound-specific carbon isotopes. *Antiquity* 82(317):702-713.

Binford, Lewis R.
1978 *Nunamiut Ethnoarchaeology*. Acadmic Press, New York, New York.

Binford, Lewis R. and J.B. Bertram
1977 Bone Frequencies and Attritional Processes. In *For Theory Building in Archaeology*, edited by L. R. Binford, pp. 77-153. Academic Press, New York.

Birnbaum, Michelle M.
2009 Home Sweet Home: Middle Woodland Structures from the Richter Site (47DR80), Washington Island, Door County, Wisconsin. *The Wisconsin Archeologist* 90(1&2):87-100.

2017 *The Richter Site (47DR80): A Millenium of Prehistoric Technolgoical and Cultural Change on Washington Island, Door County, Wisconsin*, PhD Dissertation, Department of Anthropology, University of Wisconsin-Milwaukee, Milwaukee, Wisconsin.

Bocek, B.

1986 Rodent Ecology and Burrowing Behavior: Predicted Effects on Archaeological Site Formation. *American Antiquity* 51:589-603.

Bolnick, D. and D. Smith

2007 Migration and social structure among Hopewell: Evidence from ancient DNA. *American Antiquity* 72:627-644.

Boszhardt, Robert F.

1977 Wisconsin Radiocarbon Chronology-1976: A Second Compilation. *The Wisconsin Archeologist* 58(2):87-143.

2002 Contracting Stemmed: What's the Point? *Midcontinental Journal of Archaeology* 27(1): 35-67.

Boszhardt, Robert F., James L. Theler and Thomas F. Kehoe

1986 *The Early Woodland Stage*. The Wisconsin Archeologist 67(3-4):242-262.

Bourdieu, Pierre

1977 *Outline of a Theory of Practice*. Translated by R. Nice. Cambridge University Press, Cambridge.

1990 *The Logic of Practice*. Translated by T. b. R. Nice. Polity Press, Cambridge.

Boyd, Matthew and Clarence Surette

2010 Northernmost Precontact Maize in North America. *American Antiquity* 75(1):117-133.

Bradley, R.

1996 Long Houses, Long Mounds and Neolithic Enclosures. *Journal of Material Culture* 1:239-256.

Braithwaite, Mary

1982 Decoration as Ritual Symbol: A Theoretical Proposal and Ethnographic Study in Southern Sudan. In *Symbolic and Structural Archaeology*, edited by I. Hodder, pp. 80-88. Cambridge University Press, Cambridge.

Brashler, Janet G., Michael J. Hambacher, Terrance J. Martin,
Kathryn E. Parker and James R. Robertson

2006 Middle Woodland Occupation in the Grand River Basin of Michigan. In R*ecreating Hopewell*, edited by D. K. Charles and J. E. Buikstra, pp. 261-284. University Press of Florida, Gainesvillle.

Braun, David P.

1979 Illinois Hopewell Burial Practices and Social Organization: A Reexamination of the Klunk-Gibson Mound Group. In *Hopewell Archeology: The Chillicothe Conference*, edited by D. S. Brose and N. o. Greber, pp. 66-79. Kent State University Press, Kent, Ohio.

1980 Experimental Interpretation of Ceramic Vessel Use on the Basis of Rim and Neck Formal Attributes. In *The Navajo Project: Archaeological Investigations, Page to Phoenix 500KV Southern Transmission Line*, edited by D. Fiero, R. Munson, M. McClain, S. Wilson and A. Zier. Museum of Northern Arizona, Flagstaff, Arizona.

1983 Pots as Tools. In *Archaeological Hammers and Theories*, edited by J. A. Moore and A. S. Keene. Academic Press, New York.

1986 Midwestern Hopewellian Exchange and Supralocal Interaction. In *Peer Polity Interaction and Socio-Political Change*, edited by C. Renfrew and J. Cherry, pp. 117-126. Cambridge University Press, Cambridge.

1987 Coevolution of Sedentism, Pottery Technology, and Horticulture in the Central Midwest, 200 B.C.-A.D. 600. In *Emergent Horticultural Economies of the Eastern Woodlands*, edited by W. F. Keegan, pp. 153-181. Center For Archaeological Investigations, Occasional Paper No. 7, Carbondale, IL.

1991 Why Decorate a Pot? Midwestern Household Pottery 200 BC to AD 600. *Journal of Anthropological Archaeology* 1-:360-397.

Braun, David P. and S.E. Plog

1982 The Evolution of "tribal" Social Networks: Theory and Prehistoric American Evidence. *American Antiquity* 47:504-525.

Bray, A.

1982 Mimbre black-on-white, melamine or Wedgewood? A ceramic use-wear analysis. T*he Kiva*:133-149.

Brazeau, Linda A. and David F. Overstreet

1980 *Archaeological Survey and Test Excavations in the Fox River Drainage--Waukesha, Racine, and Walworth Counties*. Great Lakes Archaeological Research Center, Report of Investigations No. 90. Milwaukee, Wisconsin.

Brink, John

1835 General Land Office Survey Notes for the Interior Sections of Township 5 North, Range 13 East, 4th Meridian. Electronic Document, http://digicoll.library.wisc.edu/cgi-bin/SurveyNotes/SurveyNotesidx?type=header&issueid=SurveyNotes.INT122E05&twp=T005NR013E, accessed September 15, 2017.

Bronitsky, G. and R. Hamer

1986 Experiments in Ceramic Technology: The Effect of Various Tempering Materials on Impact and Thermal Shock Resistance. *American Antiquity* 51(1):89-101.

Brose, David S.

1979 A Speculative Model of the Role of Exchange in the Prehistory of the Eastern Woodlands. In *Hopewell Archeology: The Chillicothe Conference*, edited by D. S. Brose and N. o. Greber, pp. 3-18. Kent State University Press, Kent, Ohio.

Brose, David S. and Michael J. Hambacher

1999 The Middle Woodland in Northern Michigan. In *Retrieving Michigan's Buried Past*, edited by J. R. Halsey, pp. 173-192. Cranbrook Institute of Science, Bloomfield Hills.

Brown, C. and William Green

2012 Botanical Remains Analysis. In *Archaeolgoical Study of Iowaville, a 1765-1824 Ioway (Baxoje) Village in Van Buren County*, edited by C. Peterson. Iowa Office of the State Archaeologist, Iowa City, Iowa.

Brown, Charles E.

1906 Record of Wisconsin Antiquities. *The Wisconsin Archeologist* 5(3-4):375.

1909 Record of Wisconsin Antiquities. *The Wisconsin Archeologist* 8(4):133.

1923 Waukesha County Townships. *The Wisconsin Archeologist* 2(2):69-119.

Brown, Charles E. and T.T. Brown

1929 Indian Village and Camp Sites along the Lower Rock River in Wisconsin. *The Wisconsin Archeologist* 9(1):22-25.

Brown, Dorothy Moulding

1937 *The Fighting Finches: tales of the pioner countryside in Rock and Jefferson Counties*. Works Progress Administration, Federal Writers Project, Folkore Section. Madison, Wisconsin.

Brown, J.A.

1964 The Northeastern Extension of the Havana Tradition. In *Hopewellian Studies*, edited by J. R. Caldwell and R. L. Hall, pp. 107-122. Illinois State Museum, Springfield, Illinois.

Brown, James A.

1979 Charnel Houses and Mortuary Crypts: Disposal of the Dead in the Middle Woodland Period. In *Hopewell Archaeology: The Chillicothe Conference*, edited by D. S. Brose and N. o. Greber, pp. 211-219. Midcontinental Journal of Archaeology, Special paper 3: 122-139. Kent State University Press, Kent, Ohio.

1986 Early Ceramics and Culture: A Review of Interpretations. In *Early Woodland Archeology*, edited by K. Farnsworth and T. E. Emerson, pp. 598-608. Center for American Archaeology Press, Kampsville, Illinois.

2005 Reflections on Taxonomic Practice. In *Woodland Period Systematics in the Middle Ohio Valley*, edited by D. Applegate and R. Mainfort, pp. 111-119. University of Alabama Press, Tuscaloosa, Alabama.

Buber, M.

1947 *Between Man and Man*. Translated by T. R. G. Smith. Routledge and Kegan Paul, London.

1958 *I and Thou*. Translated by T. R. G. Smith. Charles Scribner Sons, New York

Buikstra, Jane E.
1986 Fertility and the Development of Agriculture in the Prehistoric Midwest. *American Antiquity* 51(3) 528-54

Buikstra, J. E. and Douglas K. Charles
1999 Centering the Ancestors: Ceremonies, Mounds, and Sacred Landscapes of the Ancient North American Midcontinent. In *Archaeologies of Landscape: Contemporary Perspectives*, edited by W. Ashmore and A. B. Knapp, pp. 201-228. Blackwell, Oxford.

Buikstra, Jane E., Douglas K. Charles, and G.F.M. Rakita
1998 *Staging Ritual: Hopewell Ceremonialism at the Mound House Site, Greene County, Illinois*. Center for American Archaeology, Studies in Archaeology and History No. 1. Kampsville, Illinois.

Buikstra, Jane E. and Mark Swegle
1989 Bone Modification Due to Burning: Experimental Evidence. In *Bone Modification*, edited by R. Bonnichsen and M. H. Sorg, pp. 247-258. University of Maine, Maine.

Burt, James E., Gerald M. Barber and David L. Rigby
2009 *Elementary Statistics for Geographers*. The Guilford Press, New York.

Byers, A.M.
2004 *The Ohio Hopewell Episode: Paradigm Lost, Paradigm Gained*. University of Akron Press, Akron, Ohio.

Cain, Chester R.
2005 Using Burned Animal Bone to Look at Middle Stone Age Occupation and Behavior. *Journal of Archaeological Science* 32:873-884.

Cardinal, J.Scott
2011 *Site Identification, Delineation, and Evaluation through Quantitative Spatial Analysis: Geostatistical and GIS Methods to Facilitate Archaeological Resource Assessment*. Master's thesis, Department of Anthropology, State University of New York, Albany.

Carr, Christopher
2006 Rethinking Interregional Hopewellian "Interaction". In *Gathering Hopewell Society, Ritual, and Ritual Interaction*, edited by Troy D. Case and Christopher Carr, pp. 575-623. Springer, New York, New York.

Carr, Christopher and Troy D. Case
2006 Chapter 1: The Gathering of Hopewell. In *Gathering Hopewell Society, Ritual, and Ritual Interaction*, edited by Troy D. Case and Christopher Carr, pp. 19-50. Springer, New York, New York.

Chaplin, Raymond E.
1971 T*he Study of Animal Bones from Archaeological Sites*. Seminar Press LTD, New York, New York.

Chapman, J.C. and B.C. Keel
1979 Candy Creek-Connestee Components in Eastern Tennessee and Western North Carolina and Their Relationship with Adena-Hopewell. In *Hopewell Archaeology: The Chillicothe Conference*, edited by D. S. Brose and N. o. Greber, pp. 157-161. Midcontinental Journal of Archaeology, Special paper 3: 122-139. Kent State University Press, Kent, Ohio.

Chapman, Robert
2006 Middle Woodland/Hopewell: A View from Beyond the Periphery. In *Recreating Hopewell*, edited by Douglas K. Charles and Jane E. Buikstra, pp. 510-528. University of Florida Press, Gainesville, Florida.

Charles, D.K., J. E. Buikstra and Konigsberg
1986 Behavioral Implications of Terminal Archaic and Early Woodland Mortuary Practices in the Lower Illinois Valley. In *Early Woodland Archeology*, edited by K. B. Farnsworth and T. E. Emerson, pp. 458-474. vol. Kampsville Seminars in Archeology No. 2. Center for American Archeology, Kampsville, Illinois.

Charles, D.K., J. Van Nest and J. E. Buikstra
2004 From the Earth: Minerals and Meaning in the Hopewellian World. In S*oils, Stone, and Symbols*, edited by N. Boivin and M. Owoc, pp. 43-70. Cavendish, Portland, Oregon.

Charles, Douglas
1985 *Corporate Symbols: An Interpretive Prehistory of Indian Burial Mounds in Westcentral Illinois*, PhD dissertation, Department of Anthropology, Northwestern University, Evanston, Illinois.

1992 Woodland Demographic and Social Dynamics in the American Midwest: Analysis of a Burial Mound Survey. *World Archaeology* 24(2):175-197.

1995 Diachronic regional social dynamics: Mortuary sites in the Illinois Valley/American Bottom region. In R*egional Approaches to Mortuary Analysis*, edited by L. A. Beck, pp. 77-99. Plenum, New York, New York.

Charles, Douglas K. and Jane E. Buikstra
2006 *Recreating Hopewell*. University Press of Florida, Gainesvillle.

Charles, N. and M. McKern
1988 *Women, Food, and Families*. University Press, New York.

Chavis, D., J. Hogge, D. McMillan and A. Wandersman
1986 Sense of Community through Brunswick's Lens: A First Look. *Journal of Community Psychology* (14):24-40.

Chevalier, Alexandre, Elena Marinova and Leonor Pena-Chocarro
2014 Factors and Issues in Plant Choice. In *Early Agricultural Remnants and Technical Heritage (EARTH): 8,000 Years of Reslience and Innovation*, edited by P. C. Anderson and L. Pena-Chocarro. Oxbow Books, Oxford.

Chivis, Jeff
2016 *The Introduction of Havana-Hopewell in West Michigan and Northwest Indiana: An Integrative Approach to the Identification of Communities, Interaction Networks, and Mobility Patterns*. PhD dissertation, Department of Anthropology, Michigan State University, Michigan.

Clark, Jamie L. and Bertrand Ligouis
2010 Burned Bone in the Howieson's Poort and Post-Howieson's Poort Middle Stone Age at Sibudu (South Africa): Behavioral and Taphonomic Implications. *Journal of Archaeological Science* 37:2560-2661.

Clark, W.P.
1884 Ancient Earthworks in Rock County, Wisconsin. *American Antiquarian* 6(4):317-322.

Clauter, Jody and John D. Richards
2005 Out of Time and Out of Place: The North Bay Component at the Beaudhuin Village Site (47DR432). In *Transportation Archaeology on the Door Peninsula: Progress and Prospect 1992-2004,* edited by P. B. Richards and J. D. Richards. University of Wisconsin-Milwaukee Archaeological Research Laboratory, Report Of Investigations No. 157. Milwaukee, Wisconsin.

Cleveland, William S.
1994 *The Elements of Graphing Data*. AT&T Bell Laboratories, Murray Hill, New Jersey.

Cohen, A.P.
1985 *The Symbolic Construction of Community*. Routledge, London.

Cole, Gerald A.
1994 *Textbook of Limnology*. Waveland Press, Prospect Heights.

Collins, J.M. and L. Forman
1995 *Phase III Archaeological Salvage of the Buck Creek Mounds (13CT34 and 13CT36), Local Systems Project GRS-1792(2), Clayton County, Iowa*. Project Completion Report 18 (14). Office of the State Archaeolgoist, University of Iowa, Iowa City.

Colinvaux, Paul
1986 *Ecology*. John Wiley and Sons, New York.

Cook, Della C. and Jane E. Buikstra
1979 Health and Differential Survival in Prehistoric Populations: Prenatal Dental Effects. *American Journal of Physical Anthropology* 51 (4):649-664.

Cowan, C.W.
1997 Evolutionary Changes Associated with the Domestication of *Cucurbita pepo*: Evidence from Eastern Kentucky. In *People, Plants, and Landscapes: Studies in Paleoethnobotany*, edited by K.J. Gremillion. University of Alabama Press, Tuscaloosa.

Craig, Oliver E, Val J. Steele, Anders Fischer, Sonke Hartz, Soren H. Andersen, Aikaterini Glykou Donohue, Hayley Saul, D Martin Jones and Eva Koch
2011 Ancient lipids reveal continuity in culinary practices across the transition to agriculture in Northern Europe. *Proceedings of the National Academy of Sciences* 108(44):17910-17915.

Crawford, Gary W., Jessica L. Lytle, Ronald F. Williamson, and Robert Wojtowicz
2019 A*n Early Woodland Domesticated Chenopod (Chenopodium berlandieri subsp. jonesianum) Cache from the Tutela Heights Site, Ontario, Canada*. American Antiquity 84(1): 143-157

Crowther, Alison
2012 The Differential Survival of Native Starch during Cooking and Implications for Archaeological Analyses: A Review. *Archaeological and Anthropological Sciences* 4:221-235.

Curtis, John T.
1959 *The Vegetation of Wisconsin*. University of Wisconsin Press, Madison.

Davis, Simon J.M.
1987 *The Archaeology of Animals*. Yale University Press, United State.

Dawdy, S.L.
2010 "A wild taste": Food and colonialism in eighteenth century Louisiana. *Ethnohistory* 57:389-414.

DeBoer, Warren R.
1984 The Last Pottery Show: System and Sense in Ceramic Studies. In T*he Many Dimensions of Pottery*, edited by S. E. Van der Leeuw and A. C. Pritchard. University of Amsterdam, Amsterdam.

Decker-Walters, Deena, Terrence Walters, C. Wesley Cowan and Bruce D. Smith
1993 Isozymic characterization of wild populations of *Cucurbita pepo*. J*ournal of Ethnobiology* 13:55-72.

Deetz, James
1972 *In Small Things Forgotten.* Anchor Books, Garden City, New Jersey.

Delorit, Richard J.
1970 *Illustrated Taxonomy Manual of Weed Seeds*. Agronomy Publications, River Falls, Wisconsin.

Densmore, Frances
1979 *Chippewa Customs*. Minnesota Historical Society Press, St. Paul, Minnesota.

2005 *Strength of the Earth: The Classic Guide to Ojibwa Uses of Native Plants*. Minnesota Historical Society Press, St. Paul, Minnesota.

Dezendorf, Caroline
2013 The Effects of Food Processing on the Archaeological Visibility of Maize: An Experimental Study of Carbonization of Lime-Treated Maize Kernels. *Ethnobiology Letters* 4:12-20.

Dietler, Michael C.
2007 Culinary Encounters: Food, Identity, and Colonialism. In *The Archaeology of Food and Identity*, edited by K. C. Twiss, pp. 218-241. vol. Center for Archaeological Investigations Occasional Paper No. 34. Southern Illinois University, Carbondale, Illinois.

Dietler, Michael and Brian Hayden
2001 Digesting the Feast: Good to Eat, Good to Drink, Good to Think: An Introduction. In *Feasts: Archaeological and Ethnographic Perspectives on Food, Politics, and Power*, edited by M. Dietler and B. Hayden, pp. pp. 1-20. Smithsonian Institution Press, Washington DC.

Dietler, Michael and Ingrid Herbich
1998 Habitus, Techniques, Style: An Integrated Approach to the Social Understanding of Material Culture and Boundaries. In *The Archaeology of Social Boundaries*, edited by M. Stark. Smithsonian Institution Press, Washington, D.C.

Dirst, Victoria
1995 *Shanty Bay A Great Place to Camp in Door County*. Unpublished document. Wisconsin Department of Natural Resources.

1998 Reconsidering the Prehistory of Northeastern Wisconsin. *The Wisconsin Archeologist* 79(1):113-121

Dobres, Marcia-Anne and John E. Robb
2000 Agency in Archaeology: Paradigm or Platitude. In *Agency in Archaeology*, edited by M.-A. Dobres and J. E. Robb, pp. 3-17. Routledge, London.

Douglas, Mary
1966 *Purity and Danger: An Analysis of Concepts of Pollution and Taboo.* Routledge and Kegan Paul, London.

Driver, Harold E. and William C. Massey
1957 Comparative Studies of North American Indians. *Transactions of the American Philosophical Society* 47:165-456.

Dudd, S.N. and Richard P. Evershed
1998 Direct Demonstration of Milk as an Element of Archaeological Economies. *Science* 282:1478-1481.

Duddleson, J.Ryan
2008 Plains Woodland Pottery: A Use-Alteration Perspective. *Plains Anthropologist* 53(206):179-197.

Dunham, S.B.
2009 Nuts about Acorns: A Pilot Study on Acorn Use in Woodland Period Subsistence in the Eastern Upper Peninsula of Michigan. *The Wisconsin Archeologist* 90(1-2):113-130.

Egan-Bruhy, Kathryn C.
1988 Middle and Late Archaic Phytogeography and Floral Exploitation in the Upper Great Lakes. *Midcontinental Journal of Archaeology* 13(1):81-107.

2014 Ethnicity as Evidence in Subsistence Patterns of Late Prehistoric Upper Great Lakes Populations. *Midcontinental Journal of Archaeology Occasional Papers* 1:53-72.

Emerson, Thomas E.
1986 A Retrospective Look At The Earliest Woodland Cultures In The American Heartland. In *Early Woodland Archeology*, edited by Kenneth B. Farnsworth and Thomas Emerson, pp. 621-633. Center for American Archaeology Press, Kampsville, Illinois.

Evershed, Richard P.
1993 Biomolecular Archaeology and Lipids. *World Archaeology* 25(1):74-93.

2008a Experimental approaches to the interpretation of absorbed organic residues in archaeological ceramics. *World Archaeology* 40(1):26-47.

2008b Organic residue analysis in archaeology: the archaeological biomarker revolution. . *Archaeometry* 50(6):895-924.

Evershed, Richard P., Carl Heron and John Goad
1990 Analysis of Organic Residues of Archaeological Origin by High Temperature Gas Chromatography and Gas Chromatography-Mass Spectrometry. *Analyst* 115(10):1339-1342.

Evershed, Richard P., H.R. Mottram, S.N. Dudd, S. Charters, W. Stott, G.J.
Lawrence, A.M> Gibson, A. Conner, P.W. Blinkhorn and V. Reeves
1997 New Criteria for the Identification of Animal Fats in Archaeological Pottery. *Naturwissenschaften* 84(402-406).

Farnsworth, Kenneth
1986 Black Sand Culture Origin and Distribution. In *Early Woodland Archeology*, edited by Kenneth B. Farnsworth and Thomas Emerson, pp. 642-649. Center for American Archaeology Press, Kampsville, Illinois.

Farnsworth, Kenneth and David L. Asch
1986 Early Woodland Chronology, Artifact Styles, and Settlement Distribution in the Lower Illinois Valley Region. In *Early Woodland Archeology*, edited by Kenneth B. Farnsworth and Thomas Emerson, pp. 326-448. Center for American Archaeology Press, Kampsville, IL.

Fie, Shannon
2006 Visiting in the Interaction Sphere Ceramic Exchange and Interaction the Lower Illinois Valley In *Recreating Hopewell*, edited by Douglas K. Charles and Jane E. Buikstra, pp. 427-445. University of Press Florida, Gainesville.

Finley, Robert W.
1976 *Geography of Wisconsin, A Content Outline*. College Printing & Publishing, Madison, Wisconsin.

Fischer, F.W.
1974 *Early and Middle Woodland Settlement, Subsistence, and Population in the Central Ohio Valley*. PhD dissertation, Department of Anthropology, Washington University, St. Louis, Missouri.

Fitting, J. E. and John R. Halsey
1966 Rim Diameter and Vessel Size in Wayne Ware Vessels. *The Wisconsin Archeologist* 47:208-211.

Flanders, Richard E.
1977 *Some Observations of the Goodall Focus*. Anthropological Papers, Museum of Anthropology 61. University of Michigan, Ann Arbor.

Flick, Geralyn
1995 Produce an Early Woodland Study Unit. In *The Southeastern Wisconsin Archaeology Program: 1994-1995*, Archaeological Research Laboratory Report of Investigations No. 125, edited by L. Goldstein, pp. 151-189. University of Wisconsin Milwaukee, Milwaukee, Wisconsin.

Fortier, Andrew C.
2001 A Tradition of Discontinuity: American Bottom Early and Middle Woodland Culture History Reexamined. In *The Archaeology of Traditions*, edited by T. R. Pauketat, pp. 174-194s. University Press of Florida, Gainesville, Florida.

2006 The Land Between Two Traditions: Middle Woodland Societies of the American Bottom. In *Recreating Hopewell*, edited by Douglas K. Charles and Jane E. Buikstra, pp.328-338. University of Florida Press, Gainesville, Florida.

2008 The Archaeological Contexts and Themes of Middle Woodland Symbolic Representation in the American Bottom. *Illinois Archaeology* 20:1-47.

Fournier, Michael R.
2007 *The Gyftakis Site: A Reevaluation of a Middle Woodland Site after 30 Years*. Master's thesis. Department of Anthropology, Western Michigan University, Kalamazoo, Michigan.

Fowler, Melvin L.
1955 Ware Groupings and Decorations of Woodland Ceramics in Illinois. *American Antiquity* 20(3):213-225.

Freeman, Joan E.
1969 Millville Site, A Middle Woodland Village in Grant County. *The Wisconsin Archeologist* 50(2):37-88.

Fritz, Gayle
1999 Gender and the Early Cultivation of Gourds in Eastern North America. *American Antiquity* 64(3):417-429.

2017 Paleoethnobotany Laboratory Guide. Electronic document, https://pages.wustl.edu/peblabguide, accessed September 10, 2017.

Fritz, Gayle, Virginia Drywater Whitekiller and James W. McIntosh
2001 Ethnobotany of the Ku-nu-che: Cherokee Hickory Nut Soup. *Journal of Ethnobiology* 21:1-27.

Gallagher, Daphne E.
2014 Formation Processes of the Macrobotanical Record. In *Method and Theory in Paleoethnobotany*, edited by J. M. Marston, J. D'Alpoim Guedes and C. Warinner, pp. 19-34. University Press of Colorado, Boulder, Colorado.

Gamble, Lynn H.
2017 Feasting, Ritual Practices, Social Memory, and Persistent Places: New Interpretations of Shell Mounds in Southern California. *American Antiquity* 82(3):427-451.

Gardner, Paul S.
1997 The Ecological Structure and Behavioral Implications of Mast Exploitation Strategies. In *Peoples, Plants, and Landscapes*, edited by K. J. Gremillion, pp. 161-178. University of Alabama Press, Tuscaloosa, Alabama.

Garland, Elizabeth B. and Arthur L. DesJardins

1995 The Strobel Site (20SJ180), a Havana Middle Woodland Encampment on the Prairie River in Southwestern Michigan. *Michigan Archaeologist* 41:1-40.

2006 Between Goodall and Norton: Middle Woodland Settlement Patterns and Interaction Networks in Southwestern Michigan. In *Recreating Hopewell,* edited by Douglas K. Charles and Jane E. Buikstra, pp. 227-260. University Press of Florida, Gainesvillle.

Gauch, Hugh G.
1982 *Multivariate Analysis in Community Ecology*. Cambridge University Press, Cambridge.

Geraci, Peter John
2016 *The Prehistoric Economics of the Kautz Site: a Late Archaic and Woodland Site in Northeastern Illinois*. Unpublished Master's Thesis, Department of Anthropology, University of Wisconsin-Milwaukee. Milwaukee, Wisconsin.

Gerend, Alphonse
1904 Potsherds from Lake Michigan Shore Sites in Wisconsin. *The Wisconsin Archeologist* 4(1):3-21.

Getis, A.
2008 A History of the Concept of Spatial Autocorrelation: A Geographer's Perspective. *Geographical Analysis* 40(3):297-309.

2009 Spatial Weights Matrices. *Geographical Analysis* 41(4):404-410.

Getis, A. and J. Ord
1992 The Analysis of Spatial Association by Use of Distance Statistics. *Geographical Analysis* 24:189-206.

Giddens, A.
1984 T*he Constitution of Society: Outline of the Theory of Structuration*. University of California Press, Berkeley.

Gifford-Gonzalez, Diane
1989 Ethnographic Analogues for Interpreting Modified Bones: Some Cases from East Africa. In *Bone Modification*, edited by R. Bonnichsen and M. H. Sorg, pp. 179-221. University of Maine, Maine.

1993 Gaps in Zooarchaeological Analyses of Butchery: Is Gender an Issue. In F*rom Bones to Behavior Ethnoarchaeological and Experimental Contributions to the Interpretation of Faunal Remains*, edited by Jean Hudson, pp. 181-199. Southern Illinois University, Carbondale, Illinois.

Gifford-Gonzalez, Diane and Kojun Ueno Sunseri

2007 Foodways on the Frontier: Animal Use and Identity in Early Colonial New Mexico. In *The Archaeology of Food and Identity*, edited by K. C. Twiss, pp. 260-287. vol. Center for Archaeological Investigations Occasional Paper No. 34. Southern Illinois University, Carbondale, Illinois.

Gilbert, Miles B

1990 *Mammalian Osteology*. Missouri Archaeological Society, Columbia, Missouri.

Gilbert, Miles B, Larry B. Martin and Howard C. Savage

1996 *Avian Osteology*. Missouri Archaeological Society, Columbia, Missouri.

Goette, Susan, Michelle Williams, Sissel Johannessen and Christine Hastorf

1994 Toward Reconstructing Ancient Maize: Experiments in Processing and Charring. J*ournal of Ethnobiology* 14(1-21).

Goldstein, Lynne and Robert Kind

1987 Late Woodland Study Unit. In T*he Southeastern Wisconsin Archaeology Program: 1990-1991*, edited by L. Goldstein, pp. 93-132. Reports of Investigations No. 107. Archaeological Research Laboratory, University of Wisconsin-Milwaukee, Milwaukee, Wisconsin.

Goldstein, Lynne

1979 *Report on an Archaeological Survey of Portions of the Crawfish and Rock River Valleys Near Their Confluence in Jefferson County, Wisconsin*. University of Wisconsin-Milwaukee.

1980a *Archaeology in Wisconsin The Crawfish and Rock River Valleys A Report of University of Wisconsin-Milwaukee's Work form 1976 through 1979*. University of Wisconsin-Milwaukee, Archaeological Research Laboratory.

1980b *A Continuing Archaeological Survey of Portions of the Crawfish and Rock River Valleys near their Confluence in Jefferson County, Wisconsin*, University of Wisconsin-Milwaukee Archaeological Research Laboratory Report of Investigations No. 45. Milwaukee, Wisconsin.

1987 *The Southeastern Wisconsin Archaeology Project: 1986-1987*. University of Wisconsin-Milwaukee, Archaeological Research Laboratory. Milwaukee, Wisconsin.

1992 Middle Woodland Study Unit. In *The Southeastern Wisconsin Archaeology Program: 1991-1992*. University of Wisconsin-Milwaukee Archaeological Research Laboratory Report of Investigations No. 112. Milwaukee, Wisconsin. .

Gould, S.J.

1987 *Time's Arrow, Time's Cycle: Myth and Metaphor in the Discovery of Geological Time.* Harvard University Press, Cambridge, MA.

Graff, Sarah R.

2018 Archaeological Studies of Cooking and Food Preparation. *Journal of Archaeological Research* 26:305-351.

Graff, S.R. and A. Rodriguez-Alegria (Editors)
2012 *The Menial Art of Cooking: Archaeological Studies of Cooking and Food Preparation*. University Press of Colorado, Boulder.

Grayson, Donald K.
1973 On the Quantification of Vertebrate Archaeofaunas. *Advances in Archaeological Method and Theory* 2:199-237.

1984 *Quantitative Zooarchaeology: Topics in the Analysis of Archaeological Faunas*. Academic Press, Orlando, Florida.

Greber, N'omi B.
1991 A Study of Continuity and Contrast Between Central Scioto Adena and Hopewell Sites. *West Virginia Archaeologist* 43:1-26.

2010 Coda: Still Seeking "Hopewell". In *Hopewell Settlement Patterns, Subsistence, and Symbolic Landscapes*, edited by A. Martin Byers and DeeAnne Wymer, pp. 335-348. University of Florida Press, Gainesville, Florida.

Green, William
1999 Integrative Taxa in Midwestern Archaeology. In *Taming the Taxonomy*, edited by R. F. Williamson and C. M. Watts, pp. 25-35. Eastend Books and Ontario Archaeological Society, Toronto.

Green, William and Shirley Schermer
1988 The Turkey River Mound Group (13CT1). In *Archaeological and Paleoenvironmental Studies in the Turkey River Valley, Northeastern Iowa*, edited by W. Green. Office of the State Archaeologist, University of Iowa Press, Iowa City.

Greenacre, Michael
2007 *Correspondence Analysis*. Chapman and Hall. , Boca Raton, Florida.

Gremillion, Kristen J.
2003 Eastern Woodlands Overview. In *People and Plants in Ancient Eastern North America*, edited by P. E. Minnis, pp. 17-49. Smithosonian Institution, Washington, D.C.

Griffin, James B.
1952 Some Early and Middle Woodland Pottery Type in Illinois. In H*opewellian Communities in Illinois*, edited by T. Deuel. vol. Scientific Papers No. 5. Illinois State Museum, Springfield, Illinois.

1967 Eastern North American Archaeology: A Summary. *Science* 156:175-191.

Griffin, James B., Richard E. Flanders and P.F. Titterington
1970 *The Burial Complexes on the Knight and Norton Mounds in Illinois and Michigan*. Memoir No. 1, Museum of Anthropology. University of Michigan, Ann Arbor.

Griffiths, Dorothy M.
1978 Use-Marks on Historic Ceramics: A Preliminary Study. *Historical Archaeology* 12:68-81.

Haas, Jennifer R.
2019 [IN PRESS] *Archaeological Data Recovery at the Finch Site (47JE0902), Jefferson County, Wisconsin*. University of Wisconsin-Milwaukee, Archaeological Research Laboratory, Report of Investigations No. 445. Milwaukee, Wisconsin.

2017 Integrating Site Formation Processes, Spatial Analysis, and Local Statistics to Archaeological Site Structure: A Case Study from a Multicomponent Site in the Western Great Lakes. Paper presented at the 82nd Annual Meeting of the Society for American Archaeology, Vancouver, B.C.

Haas, Jennifer R., Katherine Shillinglaw and Rhiannon Jones

2015 A*rchaeological Investigations at the Finch Family Cemetery (47JE0902/BJE-0101), Jefferson County, Wisconsin.* University of Wisconsin-Milwaukee, Archaeological Research Laboratory, Report of Investigations No. 216. Milwaukee, Wisconsin

Hall, Robert
1950 A Style Analysis of Wisconsin Woodland Pottery. *The Wisconsin Archeologist* 31:1-35

1962 *The Archaeology of Caracajou Point.* University of Wisconsin Press, Madison, Wisconsin.

1997 *An Archaeology of the Soul: North American Indian Belief and Ritual.* University of Illinois Press, Urbana, Illinois.

Hally, David J.
1983 Use Alteration of Pottery Vessel Surfaces: An Important Source of Evidence for the Identification of Vessel Function. *North American Archaeologis*t 4(1):3-26.

Hansel, Fabricio A., Ian D. Bull and Richard P. Evershed
2011 Gas chromatographic mass spectrometric detection of dihydroxy fatty acids preserved in the 'bound' phase of organic residues of archaeological pottery vessels. *Rapid Communications in Mass Spectrometry* 25(13):1893-1898.

Harris, Oliver J.T.
2014 (Re)Assembling Communities. *Journal of Archaeological Method and Theory* 21:76-97.

Hart, J. P. and W. A. Lovis
2013 Reevaluating What We Know about the Histories of Maize in Northeastern North America: A Review of Current Evidence. *Journal of Archaeological Research* 21(2):175-216.

Hart, John P.
2008 Evolving the Three Sisters: The Changing Histories of Maize, Bean, and Squash in New York and the Greater Northeast. In *Current Northeast Paleoethnobotany II*, edited by J. P. Hart, pp. 87-99. New York State Museum, University of the State of New York, Albany.

2014 A Critical Assessment of Current Approaches to Investigations of the Timing, Rate, and Adoption Trajectories of Domesticates into the Midwest and Great Lakes. *Midcontinental Journal of Archaeology Occasional Papers* 1:161-174.

Hart, John P., Hetty Jo Brumbach and Robert Lusteck
2007 Extending the Phytolith Evidence for Early Maize (Zea mays ssp. mays) and Squash (Cucurbita sp.) in Central New York. *American Antiquity* 72(3):563-583.

Hart, John P., William A. Lovis, Robert J. Jeske and John D. Richards
2012 The Potential of Bulk 13C on Encrusted Cooking Residues as Independent Evidence for Regional Maize Histories. *American Antiquity* 77(2):315-325.

Hart, John P., Robert G. Thompson and Hetty Jo Brumbach
2003 Phytolithic evidence for Early Maize (Zea mays) in the Nothern Finger Lakes Region of New York *American Antiquity* 68(4):619-640.

Hastorf, Christine
1999 Recent Research in Paleoethnobotany. *Journal of Archaeological Research* 7(1):55-103.

2017 *The Social Archaeology of Food*: Thinking about Eating from Prehistory to the Present. Cambridge University Press, Cambridge.

Hastorf, Christine and Mary Weismantel
2007 Food: Where Opposites Meet. In *The Archaeology of Food and Identity*, edited by K. C. Twiss, pp. 308-331. vol. Center for Archaeological Investigations Occasional Paper No. 34. Southern Ilinois University, Carbondale, Illinois.

Hawsey, Kareen Lewanda
2015 V*essel Morphology and Function in the West Jefferson Phase of the Black Warrior Valley, Alabama*. Master's thesis, Department of Anthropology, University of Alabama, Tuscaloosa, Alabama.

Hayden, Brian
2001 Fabulous Feasts: A Prolegonmenon to the Importance of Feasting. In *Feasts: Archaeological and Ethnographic Perspectives on Food, Politics, and Power*, edited by M. Dietler and B. Hayden, pp. 23-64. Smithsonian Institution Press, Washington DC.

Hegmon, Michelle
1989 The Styles of Integration: Ceramic Style and Pueblo I Integrative Architecture in Southwest Colorado. In T*he Architecture of Social Integration in Prehistoric Pueblos*, edited by W. D. Lipe and M. Hegmon. Crow Canyon Archaeological Center, Cortez, Colorado.

1992 Archaeological Research on Style. *Annual Review of Anthropology* 21:517-536.

Henrikson, Harry C.
1965 Utica Hopewell, A Study of Early Hopewellian Occupation in the Illinois River Valley. In *Middle Woodland Sites in Illinois*, Volume 5, edited by Elaine Bluhm Herold, pp. 1-67. Illinois Archaeological Survey, Springfield, Illinois.

Hilger, Mary Inez
1992 [1951] C*hippewa Child Life and Its Cultural Background*. Smithsonian Institution, Washington, D.C.

Hoggett, P.
1997 Contested Communities. In *Contested Communities*, edited by P. Hoggett, pp. 3-16. Policy Press, Bristol.

Hubbard, R.N.L.B.
1976 On the Strength of the Evidence for Prehistoric Crop Processing Activities. *Journal of Archaeological Science* 3:257-265.

Hudson, Jean L.
1990 *Advancing Methods in Zooarchaeology: An Ethnoarchaeological Study Among the Aka*. PhD dissertation, Department of Anthropology, University of California, Santa Barbara, California.

1993 The Impacts of Domestic Dogs on Bone in Forager Camps. In *From Bones to Behavior: Ethnoarchaeological and Experimental Contributions to the Interpretation of Faunal Remains*, edited by J. L. Hudson. Center for Achaeological Investigations, Southern Illinois University, Carbondale, Illinois.

Hurley, William
1974 *Silver Creek Woodland Sites, Southwestern Wisconsin*. Report 6, Office of the State Archaeologist, University of Iowa, Iowa City, Iowa.

Isbell, W.H.
2000 What We Should Be Studying: The Imagined Community" and the "Natural Community". In *The Archaeology of Communities: A New World Perspective*, edited by M. A. Canuto and J. Yaeger, pp. 243-266. Routledge, London.

Jansen, Willy
2001 French Bread and Algerian Wine: Conflicting Identities in French Algeria. In *Food, Drink, and Identity*, edited by P. Scholliers, pp. 112-124. Berg, Oxford.

Janzen, Donald E.
1968 *The Naomikong Point Site and the Dimensions of Laurel in the Lake Superior Region*. Museum of Anthropology, University of Michigan, Anthropological Papers 36. Ann Arbor, Michigan.

Jervis, Ben
2017 Ceramics and Coastal Communities in Medieval (Twelfth-Fourteenth Century) Europe: Negotiating Identity in England's Channel Ports. *European Journal of Archaeology* 20(1):148-167.

Jeske, Robert J.
2006 Hopewell Regional Interactions in Southeastern Wisconsin and Northern Illinois. In *Recreating Hopewell*, edited by Douglas K. Charles and Jane E. Buikstra, pp. 286-309. University Press of Florida, Gainesvillle.

Jeske Robert J. and John D. Richards
2009 *New Dates from the North Lakes*, Paper presented in Symposium "New Light on the Northern Lakes: Revisiting the Archaeology of Northern Wisconsin". Proceedings of the 55th Annual Midwest Archaeological Conference. Iowa City, Iowa.

Jeske, Robert J. and Kira Kaufmann
2000 The Alberts Site (47Je887 & 47Je903): Excavations at a Late Archaic through Mississippian Site in Jefferson County. In *Southeastern Wisconsin Archaeology Program 1999-2000*, edited by Robert J. Jeske. University of Wisconsin-Milwaukee, Archaeological Research Laboratory, Report of Investigations No. 145. Milwaukee, Wisconsin.

Johnson, Rebecca Lynn
2002 *Change in Woodland Diet and Vessel Form at the Gast Farm Site in Southeast Iowa*. PhD Dissertation, Department of Anthropology, University of Iowa, Iowa City, Iowa.

Johansen, Chritina, Matthias Kastell, David F. Overstreet, and Linda A. Brazeau
1998 *Archaeological Recovery at the DEET Thinker (47 Cr 467), Cipra (47 Cr 414), and McCarthy (47 Cr 108) Sites, Crawford County, Wisconsin*. Great Lakes Archaeological Research Center, Report of Investigations No. 378. Milwaukee, Wisconsin.

Jones, Rhiannon and Jennifer R. Harvey
2010 *Archaeological Data Recovery at 47GT593 (Kieler I), USH 151 Corridor (Belmont to Dickeyville), Grant County, Wisconsin*. Great Lakes Archaeological Research Center, Report of Investigations No. 668. Milwaukee, Wisconsin.

Jones, Rhiannon M., Robert J. Watson, Elissa Hulit, Carrie Christman,
Alexandra Mattana, Amanda Roller and Kathryn Egan-Bruhy
2015 *Phase II Archaeological Investigations 47SB0173 Sheboygan County, Wisconsin.* Commonwealth Cultural Resources Group. Milwaukee, Wisconsin.

Kandane, Joseph B.
1988 Possible Statistical Contributions to Paleoethnobotany. In *Current Paleoethnobotany Analytical Methods and Cultural Interpretations of Archaeological Plant Remains*, edited by C. A. Hastorf and V. S. Popper, pp. 206-214. vol. Prehistoric Archeology and Ecology. University Of Chicago Press, Chicago.

Keehner, Steven P. and Mary J. Adair
2019 Modeling Kansas City Hopewell Developments and Regional Social Interactions: A Multisite Ceramic Analysis and New AMS Radiocarbon Ages. *Midcontinental Journal of Archaeology* 44 (1): 2-41.

Kehoe, Thomas F.
1975 Two More Dates for the Hilgen Spring Mound Group. *The Wisconsin Archeologist* 56(4):346-347.

Keller, Cynthia and Christopher Carr
2006 Chapter 11. Gender Role, Prestige, and Ritual Interaction across the Ohio, Mann, and Havana-Hopewellian Regions, as Evidenced by Ceramic Figurines. In *Gathering Hopewell Society, Ritual, and Ritual Interaction*, edited by Troy D. Case and Christopher Carr, pp. 428-462. Springer, New York, New York.

Keslin, R.O.
1958 A Preliminary Report of the Hahn and Horicon Sites, Dodge County, Wisconsin. *The Wisconsin Archeologist* 39(4):191-273.

King, F.B.
1985 Early Cultivated Cucurbits in Eastern North America. In *Prehistoric Food Production in North America*, edited by R.I. Ford, pp.73-97. Anthropological Papers No. 75. Museum of Anthropology, University of Michigan, Ann Arbor.

King, Jason L., Jane E. Buikstra, and Douglas K. Charles
2011 Time and Archaeological Traditions in the Lower Illinois Valley. *American Antiquity* 76(3):500-528.

Kingsley, Robert G.
1981 Hopewell Middle Woodland Settlement Systems And Cultural Dynamics In Southern Michigan. *Midcontinental Journal of Archaeology* 6:131-178.

1999 The Middle Woodland Period in Southern Michigan. In *Retrieving Michigan's Buried Past*, edited by J. R. Halsey, pp. 148-172. Cranbrook Institute of Science, Bloomfield Hills.

Kintigh, Keith W.
1984 Measuring Archaeological Diversity by Comparison with Simulated Assemblages. *American Antiquity* 49(1):44-54.

1989 Sample size, significance, and measures of diversity. In *Quantifying Diversity in Archaeology*, edited by R. B. Leonard and G. T. Jones, pp. 25-36. CUP, New York.

Knappett, C.
2005 *Thinking Through Material Culture*. University of Pennsylvania Press, Philadelphia.

Kobayashi, Masashi

1994 Use-Alteration Analysis of Kalinga Pottery: Interior Carbon Deposits of Cooking Pots. In *Kalinga Ethnoarchaeology: Expanding Archaeological Method and Theory*, edited by W. A. Longacre and J. M. Skibo. Smithsonian Institution, Washington, D.C.

Kolb, M.J. and J.E. Snead

1997 Its a small world after all: comparative analysis of community organization in archaeology. *American Antiquity* 62(4):609-628.

Koldehoff, Brad and Joseph Galloy

2006 *Late Woodland Frontiers: Patrick Phase Settlement Along the Kaskaskia Trail, Monroe County, Illinois*. Illinois Transportation Archaeological Research Program, University of Illinois at Urbana-Champaign. Urbana-Champaign, Illinois.

Kooiman, Susan M.

2012 *Old Pots, New Approaches: A Functional Analysis of Woodland Pottery from Lake Superior's South Shore.* Master' thesis, Department of Sociology, Illinois State University, Normal, Illinois.

2016 Woodland Pottery Function, Cooking, and Diet in the Upper Great Lakes of North America. *Midcontinental Journal of Archaeology* 41(3):207-230.

2018 *A Multiproxy Analysis of Culinary, Technological, and Environmental Interactions in the Northern Great Lakes Region*. PhD disseration, Department of Anthropology, Michigan State University, Michigan.

Kopytoff, Igor

1987 *The African Frontier: The Reproduction of Traditional African Societies*. Indiana University Press, Indiana.

Kuijt, Ian and Nathan Goodale

2009 Daily Practice and the Organization of Space at the Dawn of Agriculture: A Case Study from the Near East. *American Antiquity* 74(3):403-422.

Lapham, Increase

1855 *The Antiquities of Wisconsin as Surveyed and Described*. Smithsonian Contributions to Knowledge, Washington, D.C.

Leechman, Douglas

1951 Bone Grease. *American Antiquity* 16(4):355-356.

Leps, Jan and Petr Smilauer

2003 *Multivariate Analysis of Ecological Data Using Canoco*. Cambridge University Press, Cambridge.

Linton, Ralph

1944 North American Cooking Pot. *American Antiquity* 9(4):369-380.

Lippold, L.K.

1971 *Aboriginal Animal Resource Utilization in Woodland Wisconsin*. Unpublished Ph.D. Dissertation, Department of Anthropology, University of Wisconsin. Madison, Wisconsin.

1973 Animal Resource Utilization at the Cooper's Shores Site (47Ro-2), Rock County, Wisconsin. *The Wisconsin Archeologist* 54(1):36-62.

Longacre, William A.

2000 Exploring prehistorical social and political organizaiton in the American Southwest. *Journal of Anthropological Research* 56(3):287-300.

Lorant, Stefan

1946 *The New World: First Pictures of America*. Duell, Sloan, and Pearce, New York.

Lyman, R.L.

1994 *Vertebrate Taphonomy*. Cambridge Manuals in Archaeology. Cambridge University Press, Cambridge, U.K.

MacSweeney, Naoise

2011 *Community Identity and Archaeology*. University of Michigan Press, Ann Arbor.

Malainey, Mary E.

2007 Fatty Acid Analysis of Archaeological Residues: Procedures and Possibilities. In *Theory and Practice of Archaeological Residue Analysis*, edited by H. Barnard and J. W. Eerken, pp. 425-438. British Archaeological Reports International Series 1650, Oxford, U.K.

Malainey, Mary E., M. Alvarez, B. Godino, D. Zurro, E.V. Casetello and T. Figol

2014 The Use of Shells as Tools by Hunter-Gatherers in the Beagle Channel (Tierra del Fuego, South America): An Ethnoarchaeological Experiment. *Archaeological and Anthropological Sciences*. DOI 10.1007/s12520-014-0188-1, accessed January 20, 2018.

Malainey, Mary E., R. Przybylski and B. L. Sherriff

1999 Identifying the Former Contents of late Precontact Period Pottery Vessels from Western Canada using Gas Chromatography. J*ournal of Archaeological Science* 26:425-438.

2001 One Person's Food: How and Why Fish Avoidance May Affect the Settlement and Subsistence Patterns of Hunter-Gatherers. *American Antiquity* 66(1):141-161.

Malainey, Mary E. and Timothy Figol

2017 *Analysis of Lipid Residues Extracted from Early and Middle Woodland Pottery from Southeast Wisconsin*. Manuscript on file, Department of Anthropology, University of Wisconsin-Milwaukee. Milwaukee, Wisconsin.

2019 *Analysis of Lipid Residues Extracted from Pottery from 47JE00902 (Finch), Jefferson County, Wisconsin*. Manuscript on file, Department of Anthropology, University of Wisconsin-Milwaukee. Milwaukee, Wisconsin.

Mangold, William L.

2009 *The Middle Woodland Occupations of the Kankakee River Valley and Beyond: The Goodall Tradition Revisited and Reinterpreted*. Unpublished Ph.D. Dissertation, Department of Anthropology, Indiana University. Bloomington, Indiana.

Marston, John M.

2014 Ratios and Simple Statistics in Paleoethnobotanical Anslysis Data Exploration and Hypothesis Testing. In *Method and Theory in Paleoethnobotany*, edited by J. M. Marston, J. D'Alpoim Guedes and C. Warinner, pp. 163-179. University Press of Colorado, Boulder, Colorado.

Martin, A.C. and W.D. Barkley

1961 *Seed Identification Manual*. University of California Press, Berkeley.

Martin, Lawrence

1965 *The Physical Geography of Wisconsin*. Third Edition. University of Wisconsin Press, Madison.

Mason, Richard P. and Carol L. Mason

1991 Test Excavations at the Blair's Spring Site (47 Wn-428), Winnebago County, Wisconsin. *The Wisconsin Archeologist* 72(1-2):28-56.

Mason, Ronald J.

1966 *Two Stratified Sites on the Door Peninsula of Wisconsin*. Anthropological Papers No. 26, Museum of Anthropology, University of Michigan. Ann Arbor, Michigan.

1967 The North Bay Component at the Porte des Morts Site Door County, Wisconsin. *The Wisconsin Archeologist* 48(4):267-345.

1981 *Great Lakes Archaeology*. The Blackburn Press, Caldwell, New Jersey.

1986 *Rock Island-Historical Indian Archaeology in the Northern Lake Michigan Basin*. Midcontinental Journal Special Paper No. 6. Kent State University Press.

1990 The Lawton Site and the Havana Shadow in Northeastern Wisconsin. In *The Woodland Tradition in the Western Great Lakes: Papers Presented to Elden Johnson*, edited by Guy G. Gibbon, pp. 19-30. Publications in Anthropology No. 4. University of Minnesota, Minneapolis.

McElrath, D. L. and A. C. Fortier

2000 The Early Late Woodland Occupation of the American Bottom. In *Late Woodland Societies Tradition and Transformation Across the Midcontinent*, edited by T. E. Emerson, D. L. McElrath and A. C. Fortier, pp. 97-121. University of Nebraska Press, Lincoln, Nebraska.

McGill, Robert, John W. Tukey and Wayne A. Larsen

1978 Variations of Box Plots. *The American Statistician* 32:12-16.

McGregor, J.C.

1952 The Havana Site. In *Hopewellian Communities in Illinois*, edited by T. Dueuel, pp. 43-92, Illinois State Museum, Springfield, Illinois.

McKern, William C.

1931 A Wisconsin Variant of the Hopewell Culture. *Bulletin of the Public Museum of the City of Milwaukee* 10(2):185-328.

1942 The First Settlers of Wisconsin. *Wisconsin Magazine of History* 25:153-169.

1946 The Hopewellian Peoples. *The Wisconsin Archeologist* 27(1):1-9.

McKusick, Charmion R.

1981 The Faunal Remains of Las Humanas. In *Contributions to Gran Quivira Archaeolog*y, edited by A. C. Hayes. Publications in Archaeology Volume 17. National Park Service, Washington, D.C.

McPherron, Alan L.

1967 *The Juntunen Site and the Late Woodland Prehistory of the Upper Great Lakes Area* Anthropological Papers No. 30. University of Michigan, Ann Arbor.

Meinholz, Norman M. and Kelly Hamilton

2000 *Archaeological Survey and Testing Along STH 26: Archaic, Woodland and Euroamerican Settlement in Watertown, Jefferson County, Wisconsin*. Museum Archaeology Program, Research Report in Archaeology No. 115. Madison, Wisconsin.

Meinholz, Norman M. and Bethany La Fleur

2006 *Archaeological Investigations for the Rush Lake Restoration Project, and Phase II Evaluation of the Plantz Site (47 Wn-325): A Middle to Late Woodland Occupation at the Waukau Creek Outlet from Ruh Lake, Winnebago County, Wisconsin*. Wisconsin Historical Society, Museum Archaeology Program, Research Report in Archaeology No. 187. Madison, Wisconsin.

Meinkoth, M.C, J.B. Griffin, K.H. Hedman, M. Simon, T. Berres and D. Brewer

1995 *The Sister Creeks Site Mounds: Middle Woodland Mortuary Practices in the Illinois River Valley*. Illinois Transportation Archaeological Research Program, Transportation Archaeological Research Reports No. 2. Urbana-Champaign, Illinois.

Miller, Naomi F.
1988 Ratios in Paleoethnobotanical Analysis. In *Current Paleoethnobotany Analytical methods and Cultural Interpretation of Archaeological Plant Remains*, edited by C. Hastorf and V. S. Popper, pp. 72-85. University of Chicago Press, Chicago.

Minnis, Paul E.
1987 Identification of Wood from Archaelgoical Sites in the American Southwest I. Keys for Gymnosperms. *Journal of Archaeological Science* 14:121-131.

2003 *People and Plants in Ancient Eastern North America*. Smithsonian Institution, Washington, D.C.

Mobley-Tanaka, Jeannette L.
1997 Gender and Ritual Space during the Pithouse to Pueblo Transition: Subterranean Mealing Rooms in the North American Southwest. *American Antiquity* 62(3):437-448.

Moffat, Charles R
1999 *Archaeological Investigations at Several Wisconsin River Headwaters Reservoirs: Results of the 1997 and 1998 Field Seasons*. Report of Investigations. Mississippi Valley Archaeology Center Report of Investigations 315, La Crosse, Wisconsin.

Montet-White, Anna
1968 *The Lithic Industries of the Illinois Valley in the Early and Middle Woodland Period.* University of Michigan, Ann Arbor.

Montgomery, F.H.
1977 *Seeds and Fruits of Eastern Canada and Northeastern United States*. University of Toronto Press, Toronto.

Morrison, J.E., C. Sofianou, T.M. Brogan, J. Alyonis, and D. Mylona
2015 Cooking up new perspectives for late Minoan IB domestic activities: An experimental approach to understanding the possibilities and probabilities of using ancient cooking pots. In *Ceramics, Cuisine and Culture: The Archaeology and Science of Kitchen Pottery in the Ancient Mediterranean World*, edited by M. Spataro and A. Villing. Oxbow Books, Oxford, pp. 115-125.

Morrow, T.A.
1994 A Key to the Identification of Chipped-Stone Raw Materials Found on Archaeological Sites in Iowa. J*ournal of the Iowa Archeological Society* 41:108-129.

Morrow, Toby A.

2015 *Stone Tools of Minnesota.* Unpublished document. Wapsi Valley Archaeology, Inc., Anamosa, Iowa.

Mossman, Michael J.
1990 Havlor Skavlem, the "John Burroughs of Wisconsin". Electronic documented. Accessed at https://guides.beloit.edu/ld.php?content_id=14324681, February 22, 2019.

Mueller, Natalie G.
2018 Documenting the Evolution of Agrobiodiversity in the Archaeological Record: Landraces of a Newly Described Domesticate (Polygonum erectum) in North America. *Journal of Archaeological Method and Theory*. DOI.10.1007/s10816-018-9375-1, accessed April 9, 2019.

Munson, Patrick J.
1982 Marion, Black Sand, Morton, and Havana Relationship: An Illinois Perspective. *The Wisconsin Archeologist* 63:1-7.

Murdock, G.P.
1949 *Social Structure*. Macmillan, New York.

Myers, Thomas P.
2006 Hominy Technology and the Emergence of Mississippian Societies. In *Histories of Maize: Multidisclipinary Approaches to the Prehistory, Biogeography, Domestication, and Evolution of Maize*, edited by J. E. Staller, R. H. Tykot and B. F. Benz, pp. 497-510. Academic, Burlington, Massachusetts.

Nesom, Guy
2007 Plant Guide: American Hazelnut (Corylus americana Walt.). Electronic document, http://plants.usda.gov/plantguide/pdf/pg_coam3.pdf, accessed September 1, 2017.

O'Brien, Michael J. and W.R. Wood
1998 *The Prehistory of Missouri.* University of Missouri Press, Columbia, Missouri.

O'Connor, Terry
2000 *The Archaeology of Animal Bones*. Sutton Publishing Company, United Kingdom.

O'Sullivan, David O. and David J. Unwin
2010 *Geographic Information Analysis*. John Wiley and Sons, Inc., Hoboken, New Jersey.

Ohnuki-Tierney, Emiko
1993 *Rice as Self: Japanese Identities through Time*. Princeton University Press, Princeton.

Olsson, M. and S. Isaksson
2008 Molecular and isotopic traces of cooking and consumption of fish at an early medieval manor site in eastern middle Sweden. *Journal of Archaeological Science* 35:773-780.

Ord, J. and A. Getis
2001 Testing for Local Spatial Autocorrelation in the Presence of Global Autocorrelation. *Journal of Regional Science* 41:411-432.

Ortner, Sherry B.
1984 Theory in Anthropology Since the Sixties. *Comparative Studies in Society and History* 26(1):126-166.

Outram, Alan K.
2001 A New Approach to Identifying Bone Marrow and Grease Exploitation: Why the "Indeterminate" Fragments Should Not Be Ignored. *Journal of Archaeological Science* 28:401-410.

Overstreet, D. F., James A. Jr. Clark and Georgia A. Lusk
2004 *Middle Fox River Valley Archaeology-Investigations at the South Shore of Lake Poygan, Winnebago and Waushara Counties.* Center for Archaeological Research at Marquette University, Report of Investigations No. 04.005. Milwaukee, Wisconsin

Overstreet, David F.
1993 Early Woodland Study Unit for Region 7. In *Archaeological Investigations in the Sheboygan River Watershed, 1990-1993*, edited by J. D. Richards, D. F. Overstreet and P. B. Richards. vol. Great Lakes Archaeological Research Center Reports of Investigations No. 327, Milwaukee, Wisconsin.

Ozker, Doreen
1982 An Early Woodland Community At The Schultz Site 20SA2 In *The Saginaw Valley And The Nature Of The Early Woodland Adaptation In The Great Lakes Region.* Anthropological Papers No. 70, Museum of Anthropology. University of Michigan, Ann Arbor.

Pacheco, P.J. (editor)
1996 *A View from the Core: A Synthesis of Ohio Hopewell Archaeology*. Ohio Archaeological Council, Columbus, Ohio.

Pacheco, Paul J. and William S. Dancey
2006 Integrating Mortuary and Settlement Data on Ohio Hopewell Society. In *Recreating Hopewell*, edited by Douglas K. Charles and Jane E. Buikstra, pp. 3-25. University Press of Florida, Gainesvillle.

Palmer, Carol and Marijke Van der Veen
2002 Archaeobotany and the Social Context of Food. *Acta Palaebotanica* 42(2):195-202.

Pauketat, T.R.
2001 Practice and history in archaeology: An emerging paradigm. *Anthropological Theory* 1(1):1-73.

Pearsall, Deborah M.
1988 Interpreting the meaning of macroremain abundance: the impact of source and context. In *Current Paleoethnobotany Analytical methods and Cultural Interpretation of Archaeological Plant Remains*, edited by C. Hastorf and V. S. Popper, pp. 97-118. University of Chicago Press, Chicago.

2015 *Paleoethnobotany: A Handbook of Procedures*, Third Edition. Left Coast Press, Walnut, California.

Peet, Stephen D.
1890 *Prehistoric America Volume II Emblematic Mounds and Animal Effigies*. American Antiquarian Office, Chicago, Illinois.

Penman, John T.
1979 *Highway Archaeology in Wisconsin: The 1978 Field Season*. Wisconsin Department of Transportation, Archaeological Report 1. Madison, Wisconsin.

Peres, Tanya M.
2010 Methodological Issues in Zooarchaeology. In *Integrating Zooarchaeology and Paleoethnobotany*, edited by A. M. VanDerwarker and T. M. Peres, pp. 1-14. Springer, New York.

Perkl, Bradley E.
1998 *Cucurbita pepo from King Coulee, Southeastern Minnesota*. American Antiquity 63(2):279-288.

Pestle, William, Scott Demel, Michael Colvard, and Robert Pickering
2007 Skeletal Biology and Mortuary Practice at the Kubinski Site (11WI1186), A Middle Woodland Ossuary. *Illinois Archaeology: Journal of the Illinois Archaeological Survey*: 19.

Petruso, Karl M. and J.M. Wickens
1984 The Acorn in Aboriginal Subsistence in Eastern North America: A Report on Miscellaneous Experiments. In *Experiments and Observations on Aboriginal Wild Plant Food Utilization in Eastern North America*, edited by P. J. Munson, pp. 360-378. Indiana Historical Society, Indianapolis, Indiana.

Picard, Jennifer and Jennifer R. Haas
2019 Ceramic Analysis. In A*rchaeological Data Recovery at the Finch Site (47JE0902), Jefferson County, Wisconsin*, edited by Jennifer R. Haas. University of Wisconsin Archaeological Research Laboratory, Report of Investigations No. 445. Milwaukee, Wisconsin.

Pierce, Christopher
2005 Reverse Engineering the Ceramic Cooking Pot: Cost and Performance Properties of Plain and Textured Vessels. *Journal of Anthropological Archaeology* 12(2):117-157.

Pleger, Thomas C. and James Stoltman
2009 The Archaic Tradition in Wisconsin. In *Archaic Societies: Diversity and Complexity across the Midcontinent*, edited by T. E. Emerson, D. L. McElrath and A. C. Fortier, pp. 697-724. State University of New York Press, Albany, New York.

Popper, Virginia S.
1988 Selecting Quantitative Measures in Paleoethnobotany. In *Prehistoric Archeology and EcologyCurrent Paleoethnobotany Analytical Methods and Cultural Interpretations of Archaeological Plant Remains,* edited by C. A. Hastorf and V. S. Popper, pp. 53-71. vol. Prehistoric Archeology and Ecology. University Of Chicago Press, Chicago.

Potter, James M.
1997 Communal Ritual and Faunal Remains: An Example from Dolores Anasazi. *Journal of Field Archaeology* 24:353-364.

Prince, Paul
2007 Determinants and Implications of Bone Grease Rendering: A Pacific Northwest Example. *North American Archaeologist* 28(1):1-28.

Prufer, Olaf H.
1965 *The McGraw Site: A Study in Hopewellian Dynamics*. Cleveland Museum of Natural History, Cleveland, Ohio.

Quimby, George I.
1941 *The Goodall Focus: An Analysis of Ten Hopewellian Communities in Michigan and Indiana.* Indiana Historical Society, Indianapolis, Indiana.

Raviele, Maria E
2011 Experimental Assessment of Maize Phytolith and Starch Taphonomy in Carbonized Cooking Residues. *Journal of Archaeological Science* 38:708-2713.

Reber, Eleanora A., John H. Blitz and Claire E. Thompson
2010 Direct Determination of the Contents of a Ceramic Bottle from the Moundville Site, Alabama. *Midcontinental Journal of Archaeology* 35(1):37-55.

Reber, Eleanora A. and Richard P. Evershed
2006 Ancient vegetarians? Absorbed pottery residue analysis of diet in the Late Woodland and Emergent Mississippian periods of the Mississippi Valley. *Southeastern Archaeology*:110-120.

Reid, Kenneth C.
1984 Fire and Ice: new Evidence for the Production and Preservation of Late Archaic Fiber Tempered Pottery in the Middle Latitude Lowlands. *American Antiquity* 49(1):55-76.

1990 Simmering Down: A Second Look at Ralph Linton's 'North American Cooking Pot'. In *Hunter-Gatherer Pottery from the Far West*, edited by J. M. Mack, pp. 8-17. vol. Nevada State Museum Anthropological Papers No. 23. Nevada State Museum, Carson City.

Reitz, Elizabeth and Elizabeth S. Wing
2008 *Zooarchaeology: Second Edition*. Cambridge Manuals in Archaeology. Cambridge University Press, Cambridge, U.K.

Rice, Prudence M.
1987 *Pottery Analysis: A Sourcebook*. University of Chicago Press, Chicago.

Richards, John D.
1992 *Ceramics and Culture at Aztalan: A Late Prehistoric Village in Southeast Wisconsin*. PhD dissertation, Department of Anthropology, University of Wisconsin-Milwaukee, Milwaukee, Wisconsin.

Richards, John D. and Robert J. Jeske
2015 Preliminary Results of Accelerator Mass Spectometry Dating of Food Residues on Prehistoric Ceramics from the Western Great Lakes and Prairie Peninsula Regions of the Midcontinent. Unpublished manuscript, Department of Anthropology, Unviersity of Wisconsin-Milwaukee. Milwaukee, Wisconsin.

Richards, John D., D. F. Overstreet and Patricia B. Richards
1993 *Archaeological Investigations in the Sheboygan River Watershed.* Great Lakes Archaeological Research Center, Report of Investigations No. 327. Milwaukee, Wisconsin.

Roberts, Katherine M.
2019 Cucurbita spp. and Lagenaria siceraria (Molina) - Standley Squash, gourd, and pumpkin; Bottle Gourd, Paleoethnobotany Laboratory Guide, Department of Anthropology, Washington University in St. Louis. Electronic document, http://pages.wustl.edu/peblabguide/articles/1120, accessed April 9, 2019.

Roddick, Andrew and Christine A. Hastorf
2010 Tradition brought to the surface: Continuity, Innovation, and Change in the Late Formative Period, Taraco Peninsula, Bolivia. *Cambridge Archaeological Journal* 20:157-178.

Roffet-Salque, Melanie, Julie Dunne, David T. Altoft, Emmanuelle Casanova,
Lucy JE Cramp, Jessica Smyth, Helen L Whelton and Richard P. Evershed
2017 From the inside out: Upscaling organic residue analyses of archaeological ceramics. *Journal of Archaeological Science* 16:627-640.

Rogerson, Peter A.
2010 *Statistical Methods for Geography*. Sage Publications, London, U.K.

Ruby, Brett J., Christopher Carr and Douglas K. Charles
2006 Community organizations in the Scioto, Mann, and Havana-Hopewellian regions: A comparative perspective. In *Gathering Hopewell Society, Ritual, and Ritual Interaction*, edited by Troy D. Case and Christopher Carr, pp. 119-176. Springer, New York, New York.

Ruby, Brett J.
1997 *The Mann Phase: Hopewellian Subsistence and Settlement Adaptations in the Wabash Lowlands of Southwestern Indiana*. PhD dissertation, Department of Anthropology, Indiana University. Bloomington, Indiana.

Rusch, Lynn A.
1988 T*he Early and Late Woodland Occupations at the Bachmann Site (47 Sb-202) in Eastcentral Wisconsin*. Museum Archaeology Program, Research Report in Archaeology. Madison, Wisconsin.

1989 *Archaeological Field Investigations and Historic Research at the Finch Cemetery, Jefferson County, Wisconsin*. State Historical Society of Wisconsin. Madison, Wisconsin.

Rye, Owen S.
1976 Keeping Your Temper Under Control: Materials and Manufacture of Pauan Pottery. *Archaeology and Physical Anthropology in Oceania* 11(2):106-137.

1981 *Pottery Technology Principal and Reconstruction*. Taraxcum, Washington, D.C.

Sabo, Bridget Catherine
2007 *Procuring Pipestone: An Examination of Pipe Material Selection in Wisconsin from the Late Archaic to the Historic Periods*. Master's thesis, Department of Anthropology, University of Wisconsin-Milwaukee. Milwaukee, Wisconsin.

Sahlins, Marshall
1976 *Culture and Practical Reason*. University of Chicago Press, Chicago.

Salkin, Philip H.
1982 A Preliminary Report on Mitigation Excavations in the Lake Farms Archaeological District of Dane County, Wisconsin. Manuscript on file, Department of Anthropology, University of Wisconsin-Milwaukee. Milwaukee, Wisconsin.

1986 Lake Farms Phase: The Early Woodland Stage in South-Central Wisconsin as seen from the Lake Farms Archaeological District. In *Early Woodland Archeology*, edited by Kenneth B. Farnsworth and Thomas Emerson, pp. 92-120. Center for American Archeology, Kampsville, Illinois.

1989 *Archaeological Mitigation Excavations at Fox Lake, Dodge County, Wisconsin.* Archaeological Consulting Services, Report of Investigations No. 500. Madison, Wisconsin.

1994 *Archaeological Mitigation Excavations at the Airport Village Site (47Da2) in Dane County, Wisconsin.* Archaeological Consulting Services, Report of Investigations No. 871. Madison, Wisconsin.

2000 The Horicon and Kekoskee Phases: Cultural Complexity in the Late Woodland Stage in Southeastern Wisconsin. In *Late Woodland Societies: Tradition and Transformation Across the Midcontinent*, edited by T. E. Emerson, D. L. McElrath and A. C. Fortier, pp. 525-542. University of Nebraska Press, Lincoln, Nebraska.

2003 *Mitigation Excavations at the Brenton-Schneider Site (47Ra275) in Racine County, Wisconsin*. Archaeological Consulting Services, Report of Investigations No. 1443. Madison, Wisconsin.

Salzer, Robert J.

n.d. The Waukesha Focus: Hopewell in Southeastern Wisconsin. Manuscript on file, Department of Anthropology, University of Wisconsin-Milwaukee. Milwaukee, Wisconsin.

1965 *The Highsmith Site (Je4): An Early, Middle, and Late Woodland Site in the Upper Rock River Drainage*. Master's thesis, Department of Anthropology, University of Wisconsin. Madison, Wisconsin.

1969 *An Introduction to the Archaeology of Northern Wisconsin*. Unpublished Ph.D. Dissertation, Southern Illinois University, Carbondale.

1974 The Wisconsin North Lakes Project: A Preliminary Report. In *Aspects of Upper Great Lakes Anthropology-Essays in Honor of Lloyd A. Wilford*, edited by E. Johnson, pp. 40-54. Publications of the Minnesota Historical Society, St. Paul.

1986 Other Late Woodland Development. *The Wisconsin Archeologist* 67(3-4):302-314.

Sassaman, Kenneth E.

1991 *Economic and Social Contexts of Ceramic Vessel Technology in the American Southeast*. PhD dissertation, Department of Anthropology, University of Massachusetts. Amherst, Massachusetts.

1993 *Early Pottery in the Southeast Tradition and Innovation in Cooking Technology*. University of Alabama Press, Tuscaloosa, Alabama.

Scarry, C Margaret

1986 *Change in Plant Procurement and Production during the Emergence of the Moundville Chiefdom*. PhD dissertation, Department of Anthropology, University of Michigan, Ann Arbor. Ann Arbor, Michigan.

2003 Patterns of Wild Plant Utilization in the Prehistoric Eastern Woodlands. In *People and Plants in Ancient Eastern North America*, edited by P. E. Minnis, pp. 50-104. Smithsonian Books, Washington, D.C.

Scarry, C Margaret and Vincas P. Steponaitis

1997 Between Farmstead and Center: The Natural and Social Landscape of Moundville. In *People, Plants, and Landscapes: Studies in Paleoethnobotany*, edited by K. J. Gremillion, pp. 107-122. University of Alabama Press, Tuscaloosa, Alabama.

Schiffer, Michael B.

1986 Radiocarbon dating and the “old wood” problem: The case of the Hohokam chronology. *Journal of Archaeological Science* 13(1):13-30.

1988 The Effects of Surface Treatment on Permeability and Evaporatative Cooking Effectiveness of Pottery. In P*roceedings of the 26th International Archaeometry Symposium*, edited by R. Farquhar, R. Hancock and L. Pavlish. University of Toronto, Toronto.

1990 The Influence of Surface Treatment on Heating Effectiveness of Ceramic Vessels. *Journal of Archaeological Science* 17:373-381.

2004 Studying Technological Change: A Behavioral Perspective. *World Archaeology* 36(4):579-585.

Schiffer, Michael B. and A Miller

1999 *The Material Life of Human Beings: Artifacts, Behavior, and Communication*. Routledge, New York.

Schiffer, Michael B. and James M Skibo

1987 Theory and Experiment in the Study of Technological Change. *Current Anthropology* 28(5):595-622.

Schiffer, Michael B., James M Skibo, T.C. Boelke, M.A. Neupert and M. ARonson

1994 New Perspectives on Experimental Archaeology: Surface Treatments and Thermal Response of the Clay Cooking Pot. *American Antiquity* 59(2):197-217.

Schneider, Seth A.

2015 *Oneota Ceramic Production and Exchange: Social, Economic, and Political Interactions in Eastern Wisconsin Between A.D. 1050 - 1400*. PhD dissertation, Department of Anthropology, University of Wisconsin-Milwaukee, Milwaukee, Wisconsin.

Schurr, Mark

1997 The Bellinger Site (12Sj6) and the Origins of the Goodall Tradition. *Archaeology of Eastern North America* 25:125-142.

Scott, Elizabeth M.

2007 Pigeon Soup and Plover in Pyramids: French Foodways in New France and the Illinois County. In *The Archaeology of Food and Identity*, edited by K. C. Twiss, pp. 243-259. Center for Archaeological Investigations Occasional Paper No. 34. Southern Illinois University, Carbondale, Illinois.

Seeman, Mark F.

1979 The Hopewell interaction sphere: The evidence of inter-regional trade and structural complexity. *Indiana Historical Society, Prehistoric Research Series* 5:237-438.

1995 When words are not enough: Hopewell interregionalism and the use of material symbols at the GE Mound. In *Native American Interactions: Multiscalar Analyses and Interpretation in the Eastern Woodlands*, edited by M. S. Nassaney and K. Sassaman, pp. 122-143. University of Tennessee Press, Knoxville, Tennessee.

Seeman, Mark F. and J. Branch
2006 The mounded landscapes of Ohio: Hopewell patterns and placements. In *Recreating Hopewell*, edited by D. K. Charles and J. E. Buikstra, pp. 106-121. University Press of Florida, Gainesvillle.

Shaffer, Brian S. and Julia L. J. Sanchez
1994 Comparison of 1/8" abd 1/4" Mesh Recovery of Controlled Samples of Small to Medium Sized Mammals. *American Antiquity* 59(3):525-530.

Shapiro, Gary
1984 Ceramic Vessels, Site Permanence, and Group Size: A Mississippian Example. *American Antiquity* 49(4):696-712.

Shelton, China P. and Chantel White
2010 The Hand-Pump Flotation System: A New Method for Archaeobotanical Recovery. *Journal of Field Archaeology* 35(3):316-326.

Shennan, Stephen
1993 After Social Evolution: A New Archaeological Agenda. In *Archaeological Theory: Who Sets the Agenda,* edited by N. Yofee and A. Sheratt, pp. 53-59. Cambridge University Press, Cambridge.

1997 *Quantifying Archaeology*. Edinburgh University Press, Edinburgh.

Shepard, Anna O.
1956 *Ceramics for the Archaeologist*. Carnegie Institution, Washington, D.C.

Shipman, Pat, Giraud Foster and Margaret Schoeninger
1984 Burnt Bones and Teeth: An Experimental Study of Color, Morphology, Crystal Structure and Shrinkage. *Journal of Archaeological Science* 11:307-325.

Simon, Mary L.
2017 Reevaluating the Evidence for Middle Woodland Maize from the Holding Site. *American Antiquity* 82(1):140-150.

Simon, Mary L. and Kathryn E. Parker
2006 Prehistoric Plant Use in the American Bottom: New Thoughts and Interpretations. *Southeastern Archaeology* 25(2):212-257.

Sinopoli, Carla M.
1991 *Approaches to Archaeological Ceramics*. Plenum Press, New York.

Skavlem, H.L.
1914 Indian Hill Mounds. *The Wisconsin Archeologist* 13(2): 93-96.

Skibo, James M
1992 *Pottery Function A Use Alteration Perspective*. Plenum Press, New York.

2013 *Understanding Pottery Function.* Manuals in Archaeological Methods, Theory, and Technique. Springer, New York.

2015 Chapter 10 Pottery Use-Alteration Analysis. In *Use-Wear and Residue Analysis in Archaeology*, edited by J. M. Marreiros, J. F. Gibaja Bao and N. F. Bicho, pp. 189-198. Springer, New York.

Skibo, James M and Eric Blinman
1999 Exploring the Origins of Pottery on the Colorado Plateau. In *Pottery and People*, edited by J. M. Skibo and G. M. Feinman, pp. 171-183. University of Utah Press, Salt Lake City, Utah.

Skibo, James M, T.C. Butts and Michael B. Schiffer
1997 Ceramic surface treatment and abrasion resistance: An experimental study. *Journal of Archaeological Science* 24(4):311.

Skibo, James M, Mary E. Malainey and Susan M. Kooiman
2016 Early pottery in the North American Upper Great Lakes: exploring traces of use. *Antiquity* 90(353):1226-1237.

Skibo, James M., Mary E. Malainey and E. C. Drake
2009 Stone Boiling, Fire-Cracked Rock, and Nut Oil: Exploring the Origins of Pottery Making on Grand Island. *The Wisconsin Archeologist* 90(1-2):47-64.

Smith, Alexia
2014 The Use of Multivariate Statistics within Archaeabotany. In *Method and Theory in Paleoethnobotany*, edited by J. M. Marston, J. D. A. Guedes and C. Warinner, pp. 181-204. University Press of Colorado, Boulder.

Smith, Bruce D.
1995 Seed Plant Domestication In Eastern North America. In *Last Hunters First Farmers*, edited by T. D. Price and A. B. Gebauer, pp. 193-213. School of American Research Press, Santa Fe.

Smith, Huron H.
1923 *Ethnobotany of the Menomini Indians*. *Bulletin of the Public Museum of Milwaukee* 4(1).

1932 Ethnobotany of the Ojibwa Indians. *Bulletin of the Public Museum of Milwaukee* 4(3):327-525.

Smith, M.F.
1988 Function from whole vessel shape; A method and application to Anasazi Black Mesa, Arizona. *American Anthropologist* 90(4):912-923.

Smith, C. Wesley and Bruce D. Smith
2003 *Domesticated crop plants and the evolution of food production economics in eastern North America*. In People and Plants in Ancient Eastern North America, edited by Paul E. Minnis. Smithsonian Institution, Washington, D.C.

Speck, Frank G.
1909 *Ethnology of the Yuchi Indians.* University of Pennsylvania University Museum Anthropological Publications No. 1. University of Pennsylvania, Pennsylvania.

Spector, Janet D.
1970 Seed Analysis in Archaeology. *The Wisconsin Archaeologist* 51:163-190.

Speth, J.M.
1987 Seasonality Implications of Giant Canada Goose remains from Oneota sites in Wisconsin. *The Wisconsin Archeologist* 68(2):155-161.

St. Pierre, Christian Gates and Robert G. Thomson
2015 Phytolith Evidence for Early Presence of Maize in Southern Quebec. *American Antiquity* 80:408-415.

Stahl, Ann B.
2002 Colonial Entanglements and the Practices of Taste: An Alternative to Logocentric Approaches. *American Anthropologist* 104(3):824-845.

Stahl, Peter W.
1995 Differential preservation histories affecting the mammalian zooarchaeological record from the forested neotropical lowlands. In *Archaeology in the Lowland American Tropics: Current Analytical Methods and Recent applications*, edited by P. W. Stahl, pp. 154-180. Cambridge University Press, Cambridge, U.K.

2011 Ethnobiology, Historical Ecology, and the Archaeofaunal Record, and Interpreting Human Landscapes. In *Ethnobiology*, edited by E. N. Anderson, D. Pearsall, E. Hunn and N. Turner, pp. 97-113. John Wiley & Sons.

Stein, G.
2012 Food preparation, social context, and ethnicity in a prehistoric Mesopotamian colony. In *The Menial Art of Cooking: Archaeological Studies of Cooking and Food Preparation*, pp. 47-64. University Press of Colorado, Boulder.

Stencil, Zachary R.
2015 Vertebrate Evidence for Diet and Food-Processing at the Multicomponent Finch Site (47 JE-0902) in Jefferson County, Southeastern Wisconsin. Master's thesis, Department of Anthropology, University of Wisconsin-Milwaukee, Milwaukee, Wisconsin.

Steponaitis, V.P.
1983 *Ceramics, Chronology and Community Patterns: A Methodological Study at Moundville*. Academic Press, New York.

1984 Technological Studies of Prehistoric Pottery from Alabama: Physical Properties and Vessel Function. In T*he Many Dimensions of Pottery,* edited by S. E. Van der Leeuw and A. C. Pritchard. University of Amsterdam, Amsterdam.

Sterner, Katherine M.
2018 *Stone Tools and Agricultural Communitites: Economic, Microwear, and Residue Analyses of Oneota Lithic Assemblages*. PhD dissertation, Department of Anthropology, University of Wisconsin-Milwaukee, Milwaukee, Wisconsin.

Stevenson, Katherine P., Robert F. Boszhardt, Charles R. Moffat, Philip H. Salkin, Thomas C. Pleger, James L. Theler and Constance M. Arzigian
1997 The Woodland Tradition. *The Wisconsin Archeologist* 78:140-201.

Stiner, Mary C., Steven L. Kuhn, Stephen Weiner and Bar Bar-Yosef
1995 Differential Burning, Recrystallization, and Fragmentation of Archaeological Bone. *Journal of Archaeological Science* 22:223-237.

Stoessel, L.
2014 Evaluating Intensity in the Processing of Guanaco (Lama Guanicoe) at the Lower Basin of the Colorado River (Argentina): Fragmentation Levels and Fracture Pattern Analysis. *International Journal of Osteoarchaeology* 24:51-67.

Stoltman, James B.
1979 Middle Woodland Stage Communities of Southwestern Wisconsin. In *Hopewell Archaeology: The Chillicothe Conference*, edited by D. S. Brose and N. Greber, pp. 122-139. Kent State University Press, Kent, Ohio.

1986 The Prairie Phase: An Early Woodland Manifestation In The Upper Mississippi River Valley. In *Early Woodland Archeology,* edited by Kenneth B. Farnsworth and Thomas Emerson, pp. 121-136. Center for American Archaeology Press, Kampsville, Illinois.

1990 The Woodland Tradition in the Prairie du Chien Locality. In *The Woodland Tradition in the Western Great Lakes: Papers Presented to Elden Johnson*, edited by Guy G. Gibbon, pp. 239-259. Publications in Anthropology No. 4. University of Minnesota, Minneapolis.

2005 Tillmont (47CR460): A Stratified Prehistoric Site in the Upper Mississippi River Valley. *The Wisconsin Archeologist* 86(2):1-113.

2006 Reconsidering the Context of Hopewell Interaction in Southwestern Wisconsin. In *Recreating Hopewell,* edited by Douglas K. Charles and Jane E. Buikstra. University of Florida Press, Gainesville, Florida.

Stoltman, James B. and George W. Christiansen
2000 The Late Woodland Stage in the Driftless Area of the Upper Mississippi River Valley. In *Late Woodland Societies*, edited by Thomas E. Emerson, Dale L. McElrath, and Andrew C. Fortier, pp. 497-524. University of Nebraska Press, Lincoln.

Stoltman, James B. and Richard E. Hughes
2004 Obsidian in Early Woodland Contexts in the Upper Mississippi Valley. *American Antiquity* 69(4):751-759.

Stoltman, James B., David S. Brose, Ian W. Brown, Robert C. Dunnell, L.S. Klejn, William Meacham, Dan F. Morse, George H. Odell, Mario A. Rivera, and William A. Starna
1978 Temporal Models in Prehistory: An Example from Eastern North American [and Comments and Reply]. *Current Anthropology* 19(4):703-746.

Stott, Andrew W., Robert Bernstan and Richard P. Evershed
2003 Direct Dating of Archaeological Pottery by Compound Specific 14C Analysis of Preserved Lipids. *Analytical Chemistry* 75(19):5037-5045.

Stott, Andrew W., Robert Berstan, Richard P. Evershed, C. Bronk Ramsey, Robert E.M. Hedges and Martin J. Humm
2003 Direct dating of archaeological pottery by compound-specific 14C analysis of preserved lipids. *Analytical Chemistry* 75(19):5037-5045.

Stout, A.B. and H.L. Skavlem
1908 The Archaeology of the Lake Koshkonong Region. *The Wisconsin Archeologist* 7(2):47-102.

Strathern, A. and P.J. Stewart
2000 Creating Difference: A Contemporary Affiliation Drama in the Highlands of New Guinea. *Journal of the Royal Anthropological Institute* 6:1-15.

Struever, S. and G. L. Houart
1972 An Analysis of the Hopewell Interaction Sphere. In *Social Exchange and Interaction*, Anthropological Papers No. 46, edited by E. N. Wimsen, pp. 47-79. Museum of Anthropology, University of Michigan, Ann Arbor.

Struever, Stuart

1964 The Hopewell Interaction Sphere in riverine-western Great Lakes culture history. In *Hopewellian Studie*s, edited by J. R. Caldwell and R. Hall, pp. 86-106. Scientific Papers 12. Illinois State Museum, Springfield, Illinois.

1968 Woodland subsistence-settlement systems in the lower Illinois Valley. In *New Perspectives in Archeology*, edited by S. Binford and L. R. Binford, pp. 285-312. Aldine, Chicago, Illinois.

Sunseri, C.K.

2015 Food politics of alliance in a California fronter Chinatown. *International Journal of Historical Archaeology* 19: 416-431.

Sutton, David E

2001 *Rememberances of Repasts. An Anthropology of Food and Memory*. Berg, New York.

Swanton, John R.

1946 *The Indians of the Southeastern United States.* Bulletin No. 137. Smithsonian Institution, Washington D.C.

Tache, Karine and Oliver E Craig

2015 Cooperative harvesting of aquatic resources and the beginning of pottery production in north-eastern North America. *Antiquity* 89(343):177-190.

Tache, Karine and John P. Hart

2013 Chronometric Hygiene of Radiocarbon Databases for Early Durable Cooking Vessel Technologies in Northeastern North America. *American Antiquity* 78(2):359-372.

Tainter, Joseph A

1983 Woodland Social Change in the Central Midwest. *North American Archaeologist* 4(2):141-161.

Talalay, Laurie, Donald R. Keller and Patrick J. Munson

1984 Hickory Nuts, Walnuts, Butternuts, and Hazelnuts: Observations and Experiments Relevant to Their Aboriginal Exploitation in Eastern North America. In *Experiments and Observations on Aboriginal Wild Plant Food Utilization in Eastern North America*, edited by P. J. Munson, pp. 338-359. Indiana Historical Society, Indianapolis, Indiana.

Telford, R.J., E. Heegaard and H.J.B. Birks

2004 The Intercept is a Poor Estimate of a Calibrated Radiocarbon Age. *The Holocene* 14(2):296-298.

Temple, Stanley A., John R. Cary and Robert E. Rolley

1997 *Wisconsin Birds: A Seasonal and Geographic Guide.* The University of Wisconsin Press, Madison, Wisconsin.

ter Braak, Cajo J.F.
1995 Ordination. In *Data Analysis in Community and Landscape Ecology*, edited by R. H. G. Jongman, C. J. ter Braak and O. F. van Tongeren. Cambridge University Press, Cambridge.

Theler, James L. and Robert F. Boszhardt
2003 *Twelve Millennia: The Archaeology of the Upper Mississippi River Valley*. University of Iowa Press, Iowa City.

Thompson, Robert G., John P. Hart, Hetty Jo Brumbach and Robert Lusteck
2004 Phytolith Evidence for Twentieth Century B.P. Maize in Northern Iroquoia. *Northeast Anthropology* 68:25-40.

Thompson, Robert G., Rose A. Kluth and David Kluth
1994 Tracing the Use of Brainerd Ware Through Opal Phytolith Analysis of Food Residues. *The Minnesota Archaeologist* 53:86-98.

Tryon, C.A.
2006 The Destructive Potential of Earthworms on the Archaeobotanical Record. *Journal of Field Archaeology* 31: 199-202.

Tukey, John W.
1977 *Exploratory Data Analysis*. Addison-Wesley, Reading, Massachusetts.

Twiss, Kathyrn C
2007 We Are What We Eat. In *The Archaeology of Food and Identity*, edited by K. C. Twiss, pp. 1-15. Center for Archaeological Investigations Occasional Paper No. 34. Southern Illinois University, Carbondale, Illinois.

2012 The archaeology of food and social diversity. *Journal of Archaeological Research* 20: 357-395.

Uerpmann, Hans-Peter
1973 Animal Bone Finds and Economic Archaeology: A Critical Study of 'Osteo-Archaeological' Method. *World Archaeology* 4(3):307-322.

USDA [United States Department of Agriculture]
2017 Plants Database. Electronic document, https://plants.sc.egov.usda.gov/java/, accessed December 15, 2017.

U.S. National Plant Germplasm System
2019 Taxon: Cucurbita foetidissima Kunth. Electronic document, https://npgsweb.ars-grin.gov/gringlobal/taxonomydetail.aspx?12590, accessed April 9, 2019.

Van Langden, Howard and Thomas F. Kehoe
1971 Hilgen Spring Park Mound Group. *The Wisconsin Archeologist* 52(1):1-19.

Van Oyen, A.
2013 Towards a Post-Colonial Artefact Analysis. *Archaeological Dialogues* 20:81-107.

VanDerwarker, Amber M.
2003 *Agricultural Intensification and the Emergence of Political Complexity in the Formative Sierra de los Tuxtlas, Southern Veracruz, Mexico.* PhD disertation, Department of Anthropology, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina.

2006 *Farming, Hunting, and Fishing in the Olmec World*. University of Texas Press, Austin, Texas.

2010 Correspondence Analysis and Principal Components Analysis as Methods for Integrating Archaeological Plan and Animal Remains. In *Integrating Zooarchaeology and Paleoethnobotany*, edited by A. M. VanDerwarker and T. M. Peres, pp. 75-95. Springer, New York.

VanDerwarker, Amber M., Jennifer V. Alvarado and Paul Webb
2014 Analysis and Interpretation of Intrasite Variability in Paleoethnobotanical Reamins: A Consideration and Application of Methods at the Ravensford Site, North Carolina. In *Method and Theory in Paleoethnobotany*, edited by J. M. Marston, J. D'Alpoim Guedes and C. Warinner, pp. 205-234. University Press of Colorado, Boulder, Colorado.

VanDerwarker, Amber M., Dana N. Bardolph, Kristin M. Hoppa, Heather B. Thakar,
Lana S. Martin, Allison L. Jaqua, Matthew E. Biwer, and Kristina M. Gill
2016 New World Paleoethnobotany in the New Millennium (2000-2013). *Journal of Archaeological Research* 24:125-177.

VanDerwarker, Amber M. and Bruce Idol
2008 Rotten Food and Ritual Behavior: Late Woodland Plant Foodways and Special Purpose Features at Buzzard Rock II, Virginia (44RN2/70). *Southeastern Archaeology* 27:61-77.

VanDerwarker, Amber M. and Tanya M. Peres
2010 *Integrating Zooarchaeology and Paleoethnobotany*. Springer, New York.

Varien, Mark D.
1999 *Sedentism and Mobility in a Social Landscape*. University of Arizona Press, Tucson, Arizona.

Vehik, Susan C.
1977 Bone Fragments and Bone Grease Manufacturing: A review of their Archaeological Use and Potential. *Plains Anthropologist* 22(77):169-182.

Velleman, Paul F. and David C. Hoaglin
1982 *Applications, Basics, and Computing Exploratory Data Analysis*. Duxbury Press, Boston.

Villings, A. and M. Spataro
2015 Investigating ceramics, cuisine and culture: Past, present and future. In *The Archaeology and Science of Kitchen Pottery in the Ancient Mediterranean World,* edited by M. Spataro and A. Villing, pp. 1-25. Oxbow Books, Oxford.

Vogel, Gregory
2012 Biomantle Formation and Site Preservation on Terraces of Low Order Streams in the Ozark Uplands. *Midcontinental Journal of Archaeology* 37(1):73-98.

Walthall, John A., Stephen H. Stow and Marvin J. Karson
1979 Ohio Hopewell Trade: Galena Procurement and Excange. In *Hopewell Archaeology: The Chillicothe Conference,* edited by D. S. Brose and N. Greber, pp. 247-253. Kent State University Press, Kent, Ohio.

Watanabe, J.M.
1992 *Maya Saints and Souls in a Changing World*. University of Texas Press, Austin.

Watson, Patty Jo
1976 In Pursuit of Prehistoric Subsistence: A Comparative Account of Some Contemporary Flotation Techniques. *Midcontinental Journal of Archaeology* 1(1):77-100.

Watson, Robert J., Jennifer R. Harvey, James L McEachran and Machelle R. Lee
2003 *Phase I and II Archaeological Investigations of the Preferred Alternative for the STH 26 Reconstruction in Dodge, Jefferson and Rock Counties, Wisconsin*. Great Lakes Archaeological Research Center, Report of Investigations No. 518. Milwaukee, Wisconsin.

West, George
1905 The Aboriginal Pipes of Wisconsin. *The Wisconsin Archeologist* 4(3/4):47-228.

Wheeler, Alwyne and Andrew K.G. Jones
1989 *Fishes*. Cambridge Manuals in Archaeology. Cambridge University Press, Cambridge, U.K.

Whiteford, A.H.
1949 A Report on the Outlet Site on Lake Monona. *The Wisconsin Archeologist* 30(1):22-35.

Whittle, A.
2005 Lived Experience in the Neolithic of the Great Hungarian Plain. In *Un-Settling the Neolithic*, edited by D. Bailey, A. Whittle and V. Cummings, pp. 64-70. Oxbow, Oxford.

Wiersum, Wayne Edward
1968 *The Cooper's Shore Site (RO2): A Late Havana-Hopewell Village Site in Southcentral Wisconsin.* Master's thesis, Department of Anthropology, University of Wisconsin, Madison, Wisconsin.

Wilbur, C. Keith
1996 *The New England Indians*. Rowman and Littlefield, Summit, Pennsylvania.

Wilkinson, Leland, MaryAnn Jill, Stacey Miceli, Gregory Birkenbeuel and Erin Vang
1992 *Systat Graphics*. SYSTAT, Inc., Evanston, Illinois.

Winkler, Daniel M., Dustin Blodgett and Robert J. Jeske
n.d. The Lithic Resources of Wisconsin: A Guide to Lithic Mateirals that are Located in Wisconsin. Manuscript on file, Department of Anthropology, University of Wisconsin-Milwaukee. Milwaukee, Wisconsin.

Wittry, Warren L.
1959 Archaeological Studies of Four Wisconsin Rockshelters. *The Wisconsin Archeologist* 40(4):137-267.

Wolforth, Thomas R.
1995 An Analysis of the Distribution of Steuben Punctated Ceramics. *The Wisconsin Archeologist* 76:27-47.

Wood, E.F.
1936 A Central Basin Manifestation in Eastern Wisconsin. *American Antiquity* 1:215-219.

Wright, Patti J.
2010 Methodological Issues in Paleoethnobotany: A Consideration of Issues, Methods, and Cases. In I*ntegrating Zooarchaeology and Paleoethnobotany*, edited by A. M. VanDerwarker and T. M. Peres, pp. 37-64. Springer, New York.

Wymer, DeeAnne
2009 The Paleoethnobotanical Assemblage from the 1971-1977 Ohio Historical Society Excavations at the Seip Earthworks. *Midcontinental Journal of Archaeology* 34(1):123-142.

Yaeger, Jason
2000 The Social Construction of Communities in the Classic Maya Countryside: Strategies of Affiliation in Western Belize. In *The Archaeology of Communities a New World Perspective*, edited by M. A. Canuto and J. Yaeger. vol. 123-142. Routledge, London.

Yaeger, Jason and Marcello A. Canuto
2000 Introducing and Archaeology of Communities. In *The Archaeology of Communities a New World Perspective*, edited by M. A. Canuto and J. Yaeger. vol. 1-15. Routledge, London.

Yarnell, Richard A.
1964 *Aboriginal Relationships Between Culture and Plant Life in the Upper Great Lakes Region*. Anthropological Papers, Museum of Anthropology, University of Michigan 23, Ann Arbor, Michigan.

1976 Early Plant Husbandry in Eastern North America. In *Cultural Change and Continuity*, edited by C. Cleland, pp. 265-273. Academic Press, New York.

1982 Problems of Interpretation of Archaeological Plant Remains of the Eastern Woodlands. *Southeastern Archaeology* 1(1):1-7.

Yerkes, Richard W.

1981 Fish Scale Analysis at the Pipe Site (47Fd10) Fond du Lac County, Wisconsin: An Investigation of Seasonal Patterns in Oneota Fishing Practices. *The Wisconsin Archeologist* 62(4):533-556.

Young, Lisa C. and Tammy Stone

1990 The Thermal Properties of Textured Ceramics: An Experimental Study. *Journal of Field Archaeology* 17(195-203).

Zalucha, L. Anthony

1988 Paleoethnobotanical Analysis of the Bachman Site (47SB202), Sheboygan County, Wisconsin. In *The Early and Late Woodland Occupations at the Bachmann Site (47 Sb-202) in Eastcentral Wisconsin*, edited by L. A. Rusch. Museum Archaeology Program, Research Report in Archaeology, Madison, Wisconsin.

Appendix A. Review of WHPD Data for Early and Middle Woodland Sites that have been Excavated

Excavated Sites in Southeastern Wisconsin Harboring an Early Woodland Component Based on WHPD Data (2017) (continues)

Site No.	Site Name	Investigation Type	County	Reference
47DA0002	Airport Village	Phase III	Dane	Salkin 1994
47DA0003	Outlet	Other: Mound	Dane	Bakken 1949; Whiteford 1949
47DA0108		Phase II	Dane	Haas and Jones 2013
47DO0129	Hahn I	Limited Testing	Dodge	Keslin 1958
47DA0261	Veith	Phase III	Dane	Salkin 1993
47DA0413		Phase II	Dane	Christiansen 2005
47DA0457	Canoe Site	Phase II	Dane	Salkin 1982, 1986
47DA0459	Beach Site	Phase II	Dane	Salkin 1982, 1986
47DA0529	Takabaka-Mosbacher	Phase III	Dane	Van Dyke 1991
47DA0610	River Site	Phase III	Dane	Salkin 2002
47DA0642	Statz	Phase III	Dane	Meinholz and Kolb 2007
47DA0712	Terrace	Phase III	Dane	Van Dyke 1991
47DA0713	Site 6	Phase III	Dane	Van Dyke 1991
47DA0714	La Follette Park	Phase III	Dane	Van Dyke 1991
47DA1038	Prairie Knoll	Limited Testing	Dane	Dirst 2004
47DA1428	FS 12.033-01	Phase III	Dane	Haas et al. 2017
47DA1429	Babcock Park	Phase I	Dane	Kubicek et al. 2013
47DO0047	Elmwood Island	Phase III	Dodge	Salkin 1989
47DO0393	Luedke Site	Phase III	Dodge	Salkin 1993
47JE0002	Carcajou Point	Phase III	Jefferson	Rosebrough 2017
47JE0004	Highsmith	Major Excavations	Jefferson	Salzer 1965, n.d.
47JE0096	Rufus Bingham	Limited Testing	Jefferson	Haas et al. 2015; Schneider et al. 2017
47JE0160	Moehling	Phase II	Jefferson	Goldstein 1982
47JE0239	Dillon	Other	Jefferson	SHSW 1963 (WHPD Record)
47JE0757	Trillium	Phase II	Jefferson	Goldstein 1983
47JE0879		Phase II	Jefferson	Egan-Bruhy et al. 2002
47JE0902	Finch	Phase III	Jefferson	Haas 2017
47JE1054	Merles Creek	Phase II	Jefferson	Meinholz and Hamilton 2000
47JE1068	Hinstorf	Phase II	Jefferson	Watson et al. 2003
47JE1142	Strauss Neis	Phase III	Jefferson	Kubicek et al. 2011
47JE1192	Jaco	Other: Salvage	Jefferson	Jeske et al. 2010
47JE887 & 47JE0903	Alberts Site	Limited Testing	Jefferson	Jeske and Kaufman 2000; Jeske 2006
47KN0041	Barnes Creek	Limited Testing	Kenosha	Goldstein 1995; Jeske et al. 2010; Haas 1996

Excavated Sites in Southeastern Wisconsin Harboring an Early Woodland Component Based on WHPD Data (2017) (concluded)

Site No.	Site Name	Investigation Type	County	Reference
47MI0348		Phase I & Test Exc	Milwaukee	James and Benchley 1981
47OZ0007	Hilgen Springs Mound	Other	Ozaukee	Van Langen & Kehoe 1971; Kehoe 1971
47OZ0183	Schwanz	Phase I & II	Ozaukee	Van Dyke and Mikos 1993
47RA0156	Vandyke-Bergnofer	Phase III	Racine	Hendrickson 1988
47RO0002	Cooper’s Shores	Major Excavations	Rock	Wiersum 1968
47RO0009	Riverside Park	Phase II	Rock	Salkin 2001
47RO0342	Arner Site	Phase II	Rock	Salkin 2001
47SB0029	Henschel	Other	Sheboygan	Overstreet 1993
47SB0173		Phase II	Sheboygan	Jones et al. 2015; Kubicek et al. 2015
47SB0202	Bachman	Phase III	Sheboygan	Rusch 1988
47SB0374	Theel	Other	Sheboygan	Jeske et al. 2010
47WL0300	Ron Earl	Phase III	Walworth	Overstreet et al. 2003
47WK0327	Convent Knoll	Phase III/Salvage	Waukesha	Overstreet 1980
47WK0498	Nicks Site	Other/Salvage	Waukesha	Holliday 1992
47JE0463	Weisflog	Phase II	Jefferson	Goldstein 1979
47WK0236	Harvey	Other	Waukesha	Spector 1970
47DA0182	Lange	Phase II	Dodge	Goldstein 1979
47KN0040	Chesrow	Phase II	Kenosha	Overstreet 1987

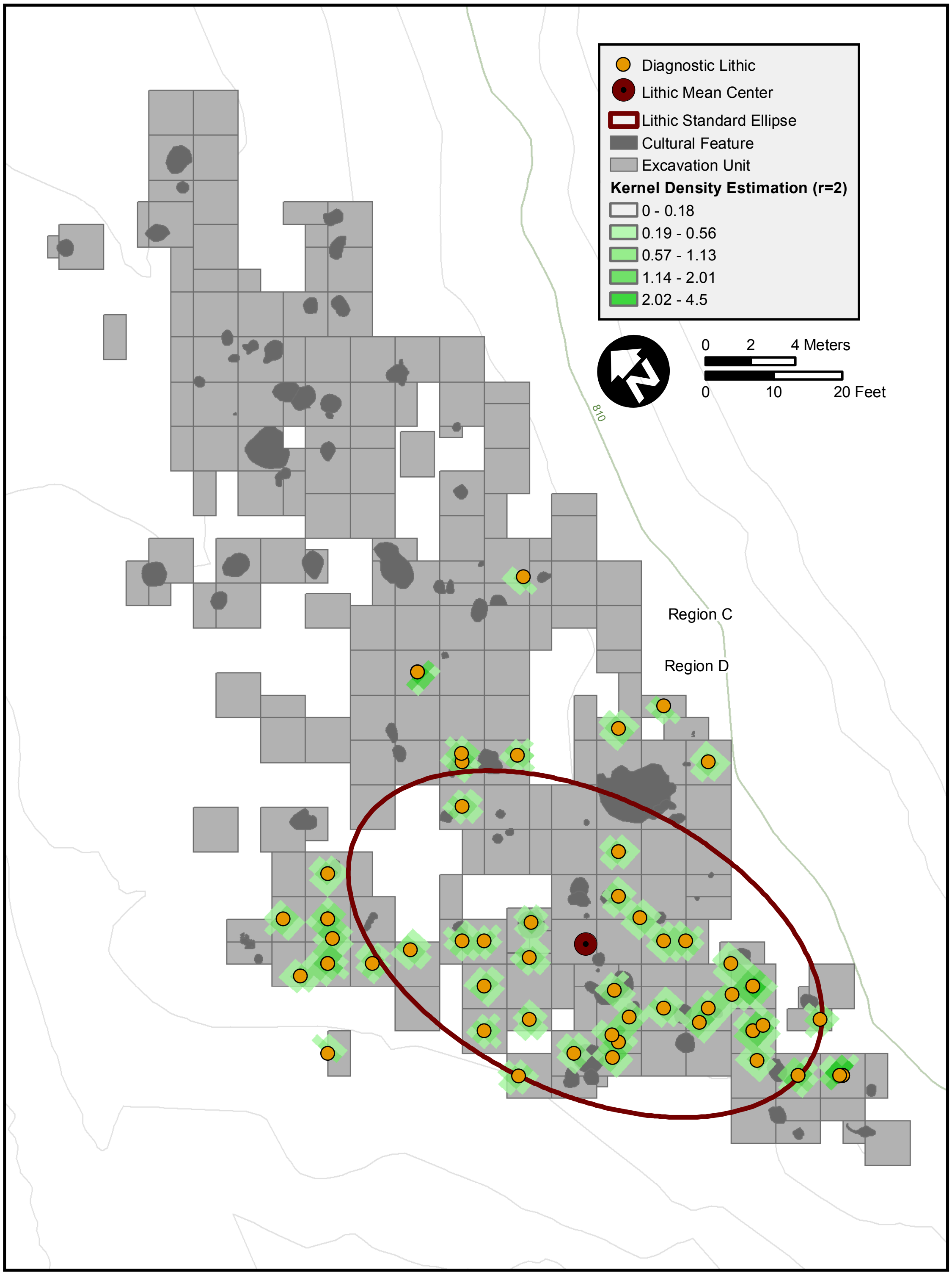
Excavated Sites in Southeastern Wisconsin Harboring an Middle Woodland Component Based on WHPD Data (2017) (continues)

Site No.	Site Name	Investigation Tye	County	Reference
47DA0002	Airport Village	Phase III	Dane	Salkin 1994
47JE887 & 47JE0903	Alberts Site	Limited Testing	Jefferson	Jeske and Kaufman 2000; Jeske 2006
47RO0342	Arner Site	Phase II	Rock	Salkin 2001
47DA1429	Babcock Park	Phase I	Dane	Kubicek et al. 2013
47DA0107	Barber Campsite	Phase II	Dane	Haas and Jones 2013
47WK0063	Barforth Blood	Phase II	Waukesha	Brazeau and Overstreet 1980
47DA0459	Beach Site	Phase II	Dane	Salkin 1982, 1986
47DA0480	Bird Effigy	Phase II	Dane	Haas et al. 2012
47RO0313	Boy Scout	Phase II	Rock	Salkin 2001
47RA0275	Brenton Schneider	Phase III	Racine	Salkin 2003
47DA0457	Canoe Site	Phase II	Dane	Salkin 1982, 1986
47JE0002	Carcajou Point	Phase III*	Jefferson	Rosebrough 2017
47KN0040	Chesrow	Phase II	Kenosha	Overstreet 1987
47RO0002	Cooper's Shores	Major Excavations	Rock	Wiersum 1968
47JE0093	Crab Apple Point	Limited Testing	Jefferson	Haas et al. 2015; Schneider et al. 2017
47JE0239	Dillon	Other	Jefferson	SHSW 1963 (WHPD Record)
47DO0047	Elmwood Island	Phase III	Dodge	Salkin 1989; UWM 2018 Monitoring
47JE0902	Finch	Phase III	Jefferson	Haas 2017
47DA1428	FS 12.033-01	Phase III	Dane	Haas et al. 2017
47DO0129	Hahn I	Limited Testing	Dodge	Keslin 1958
47WK0236	Harvey	Other	Waukesha	Spector 1970
47JE0004	Highsmith	Major Excavations	Jefferson	Salzer 1965, n.d.
47OZ0007	Hilgen Springs Mound	Other	Ozaukee	Van Langen & Kehoe 1971; Kehoe 1971
47GT593	Kieler I	Phase III	Grant	Jones and Harvey 2010a
47GT594	Kieler II	Phase III	Grant	Jones and Harvey 2010c
47DO0155	Kolterman Mound Group	Phase III	Dodge	Wittry and Bruder 1955
47DA0714	La Follette Park	Phase III	Dane	Van Dyke 1991
47DA0182	Lange	Phase II	Dodge	Goldstein 1979
47DO0393	Luedke Site	Phase III	Dodge	Salkin 1993
47JE1054	Merles Creek	Phase II	Jefferson	Meinholz and Hamilton 2000
47WL0110	Mile Long	Phase III	Walworth	Overstreet et al. 1995; Salkin 1992
47JE0160	Moehling	Phase II	Jefferson	Goldstein 1982
47DA0736	Murphy Site	Phase III	Dane	Hawley 2009
47DO0258	Old Bear	Phase III	Dodge	WHPD 2017 (only mention is in the WHPD record)
47DA0003	Outlet	Other: Mound	Dane	Bakken 1949; Whiteford 1949

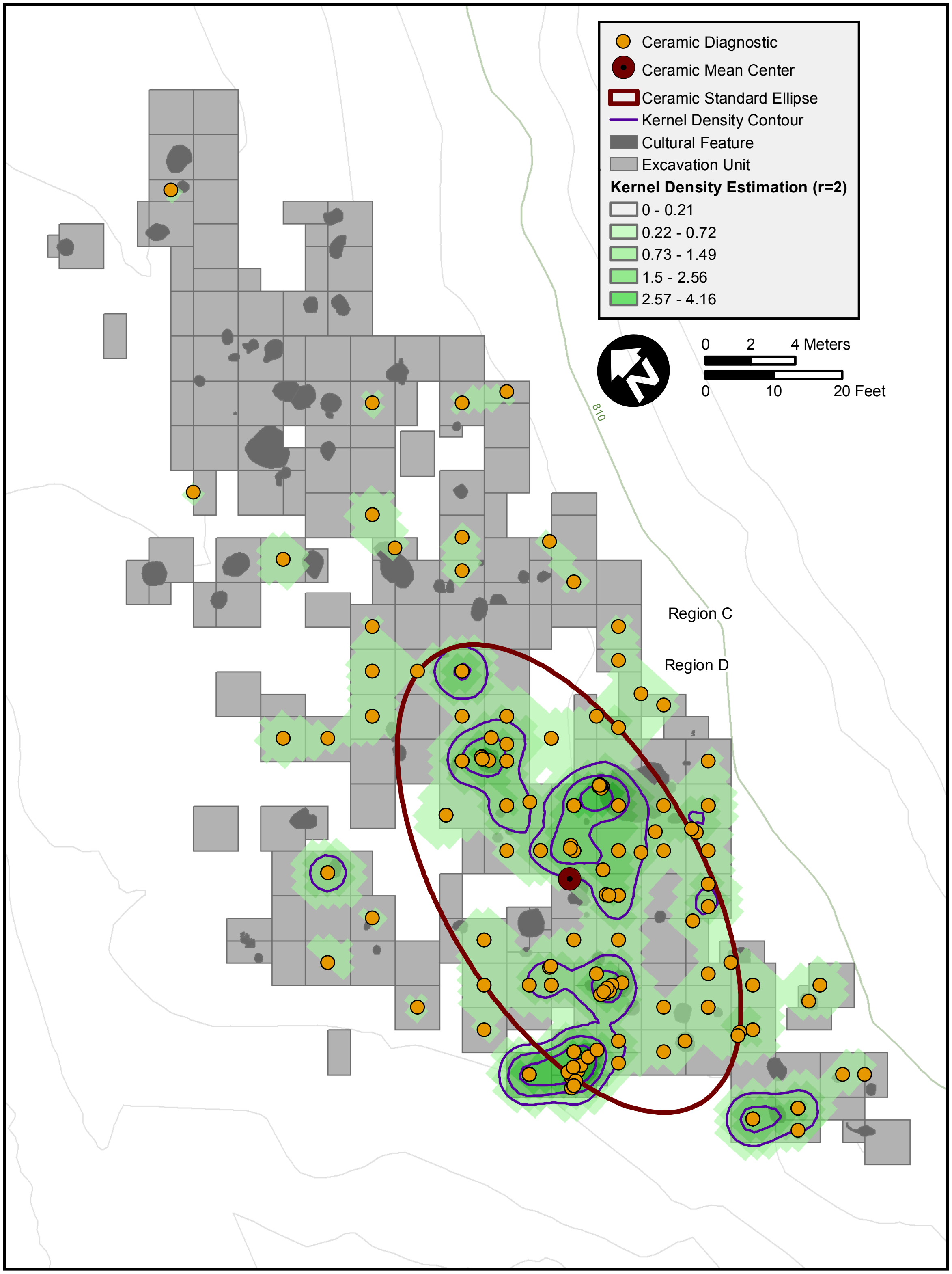
Excavated Sites in Southeastern Wisconsin Harboring an Middle Woodland Component Based on WHPD Data (2017) (concluded)

Site No.	Site Name	Investigation Tye	County	Reference
47WK0199	Peterson	Phase II	Waukesha	Brazeau and Overstreet 1980; Watson 2002
47KN0249	Pike Site	Phase III	Kenosha	Sasso 2001
47JE0676	Pitzner	Phase II	Jefferson	Goldstein 1980a;1980b, 1992
47WN0325	Plantz	Limited Testing	Winnebago	Kuehn et al. 2008; Meinholz & La Fleur 2006
47DA1038	Prairie Knoll	Limited Testing	Dane	Dirst 2004
47DA0768	River Quarry	Phase III	Dane	Hawley 2009
47RA0288	Riverside Park	Phase II	Racine	Schneider et al. 2016
47WL0300	Ron Earl	Phase III	Walworth	Overstreet et al. 2003
47JE0096	Rufus Bingham	Limited Testing	Jefferson	Haas et al. 2015; Schneider et al. 2017
47RO0324	Schneider Site	Phase II	Rock	Salkin 2001
47OZ0183	Schwanz	Phase I & II	Ozaukee	Van Dyke and Mikos 1993
47DR0011	Shanty Bay	Other	Door	Dirst 1995
47MO1 to 47MO5	Silver Creek Site	Limited Testing	Monroe	Hurley 1974
47DA0529	Takabaka-Mosbacher	Phase III	Dane	Van Dyke 1991
47DA0712	Terrace	Phase III	Dane	Van Dyke 1991
47JE0757	Trillium	Phase II	Jefferson	Goldstein 1983
47RA0156	Vandyke-Bergnofer	Phase III	Racine	Hendrickson 1988
47JE0463	Weisflog	Phase II	Jefferson	Goldstein 1979
47JE1166	Wolters	Phase III	Jefferson	Haas et al. 2016
47DA0108		Phase II	Dane	Haas and Jones 2013
47SB0173	Kohler	Phase II	Sheboygan	Jones et al. 2015; Kubicek et al. 2015

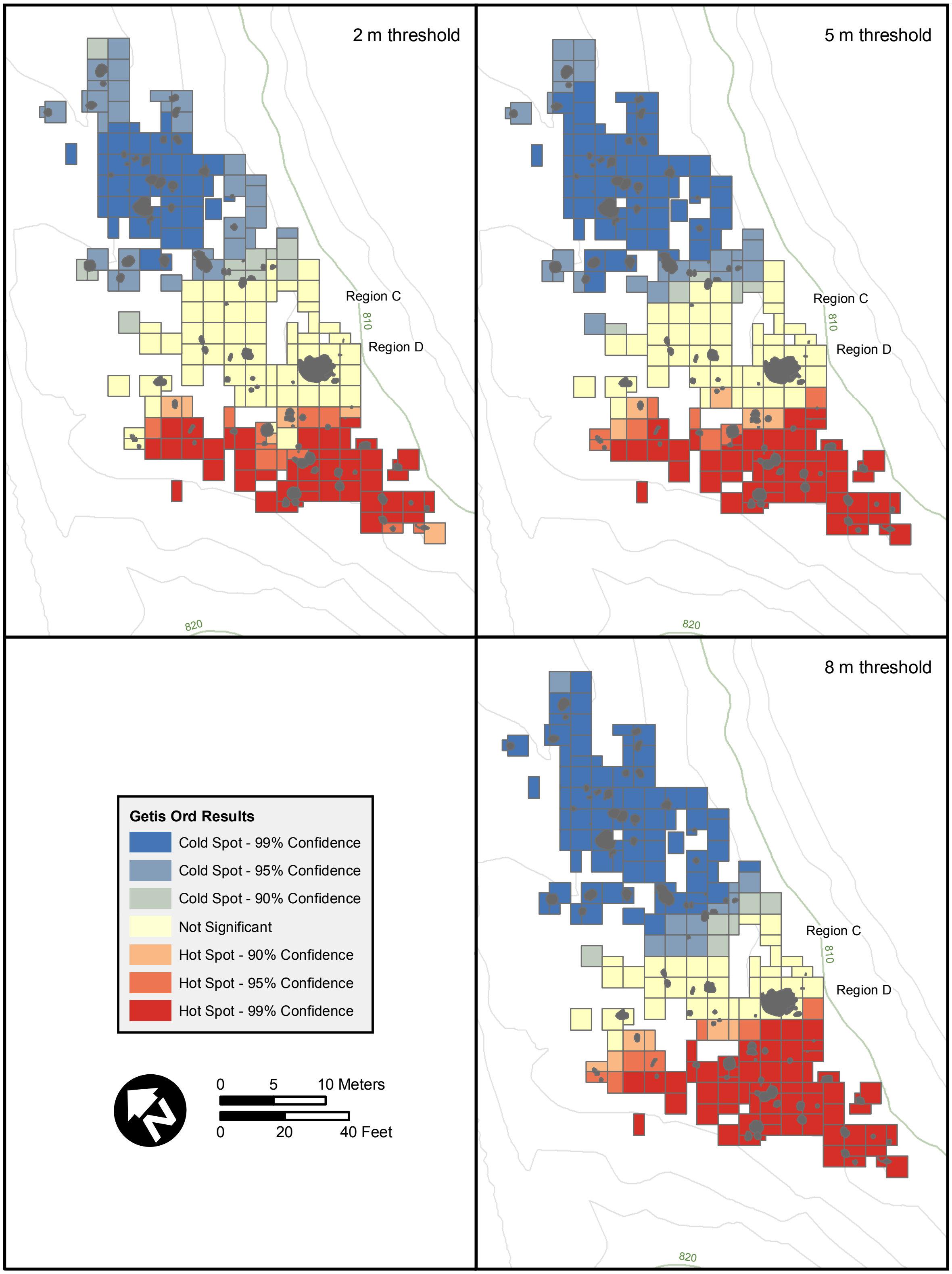
Appendix B. Results of the Quantitative Spatial Analysis (from Haas 2019)



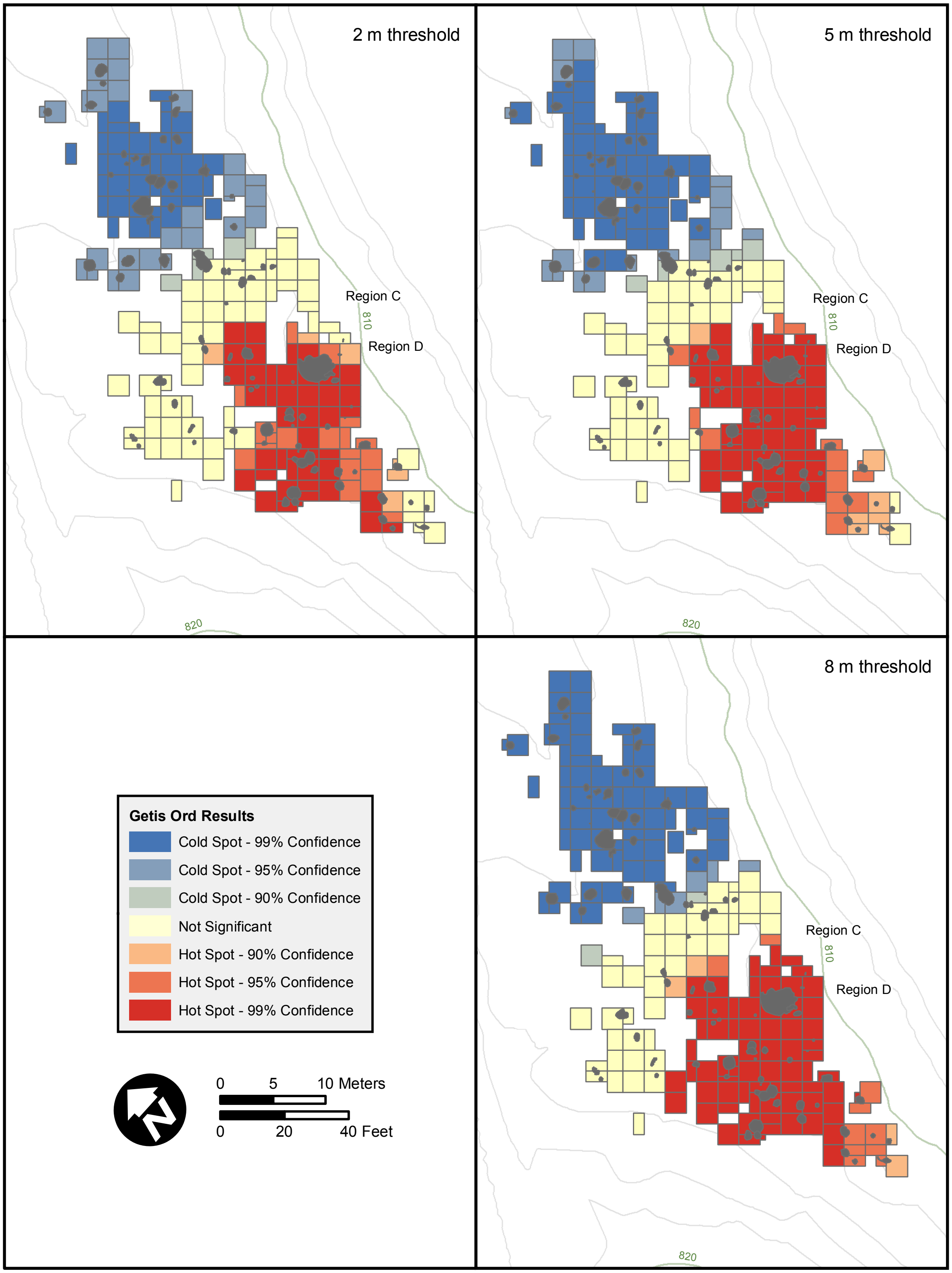
Results of the descriptive and spatial statistics for the Early Woodland lithics in Regions C and D.



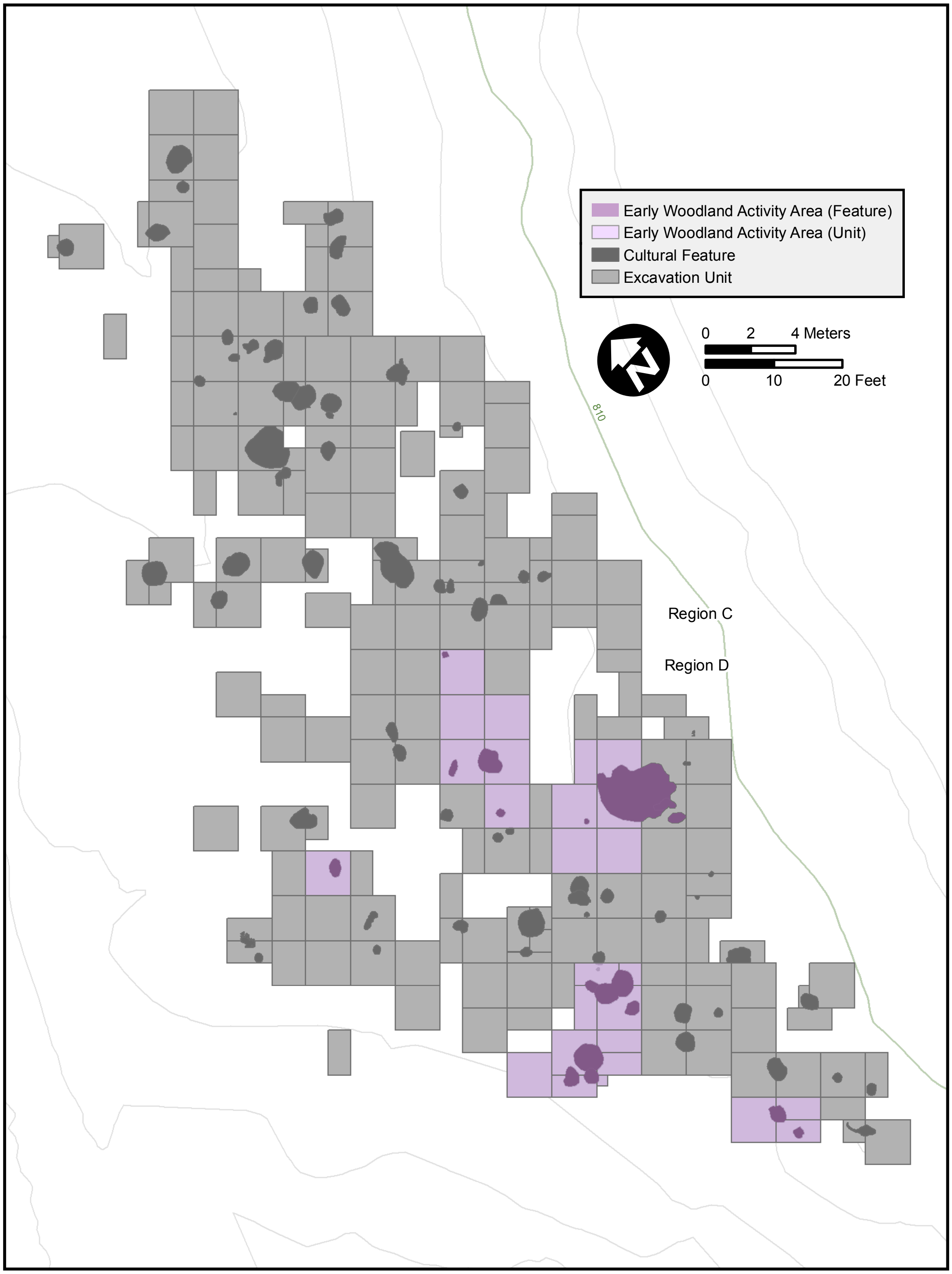
Results of the descriptive and spatial statistics for the Early Woodland ceramics in Regions C and D.



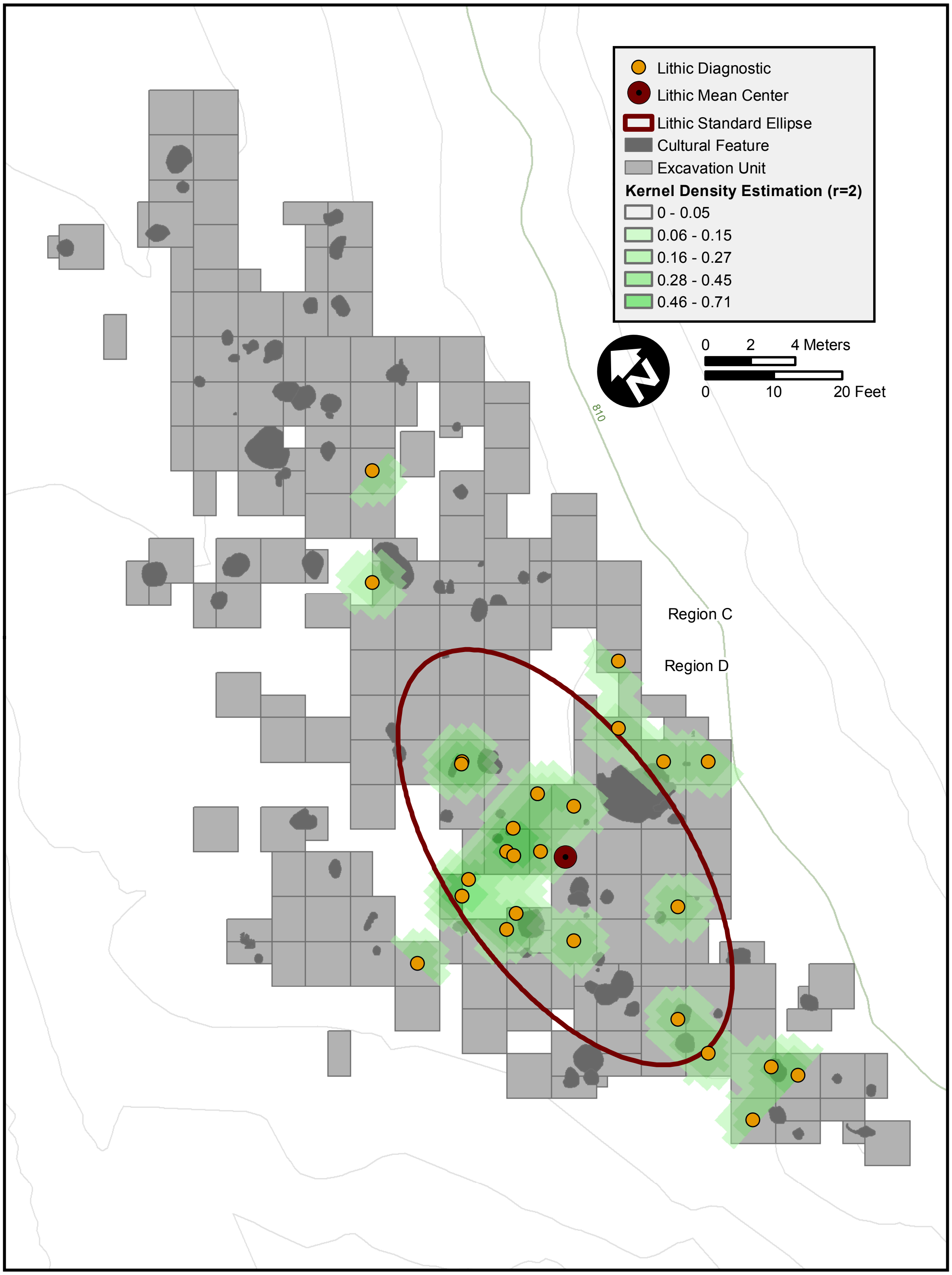
Results of the Getis Ord Gi* statistic for the Early Woodland lithics in Regions C and D.



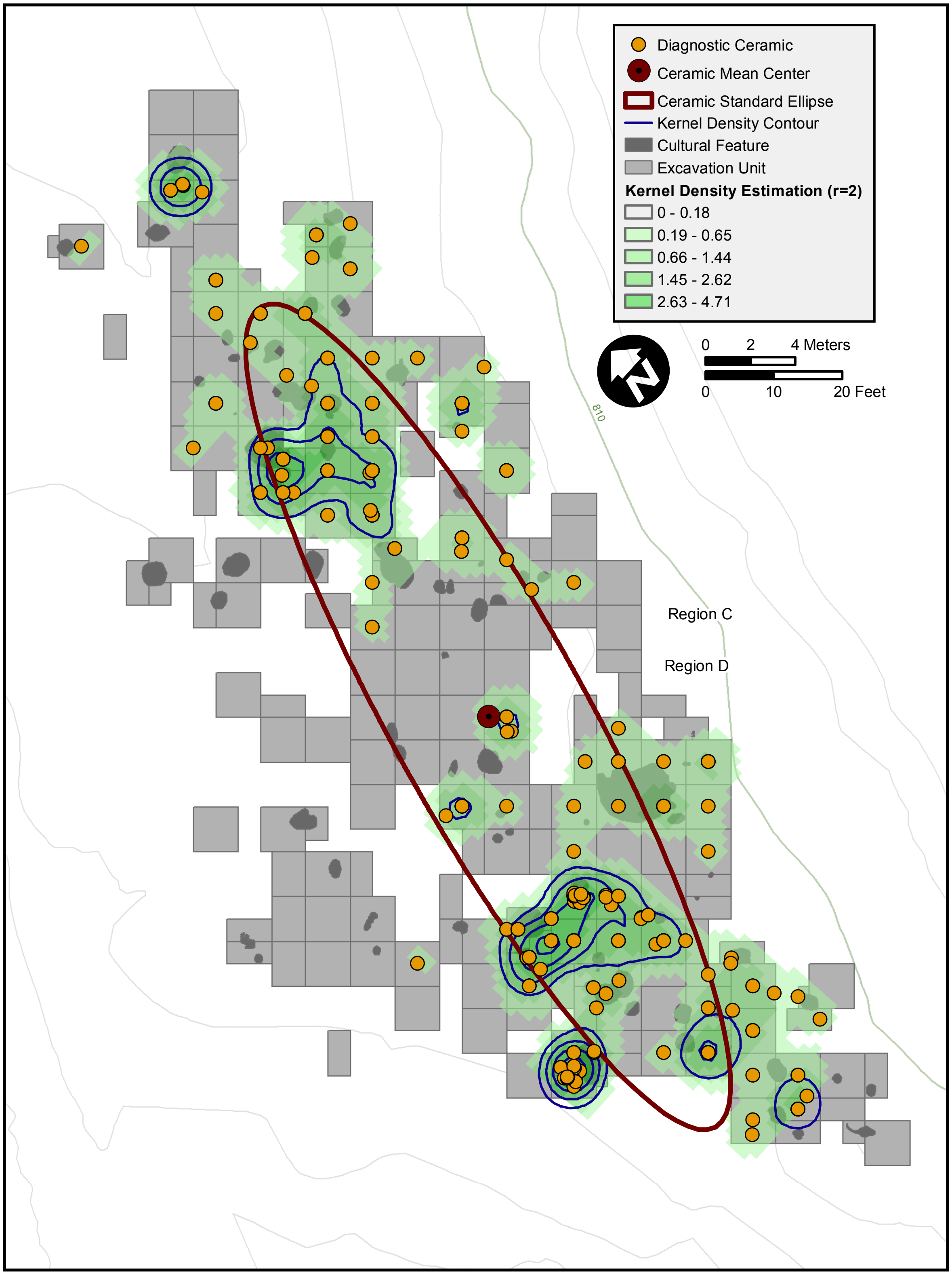
Results of the Getis Ord Gi* statistic for the Early Woodland ceramics in Regions C and D.



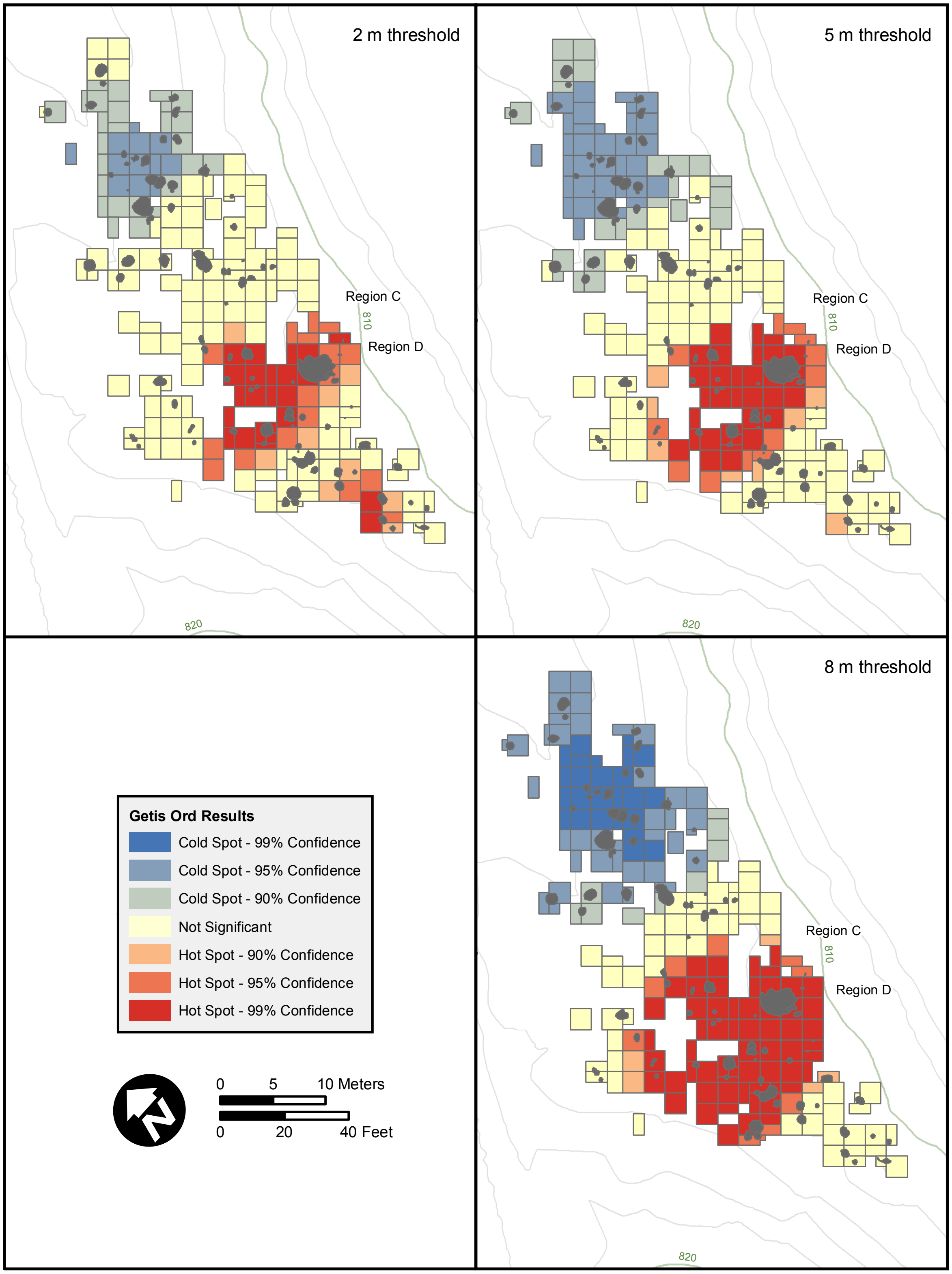
Activity area associated with the Early Woodland component in Regions C and D.



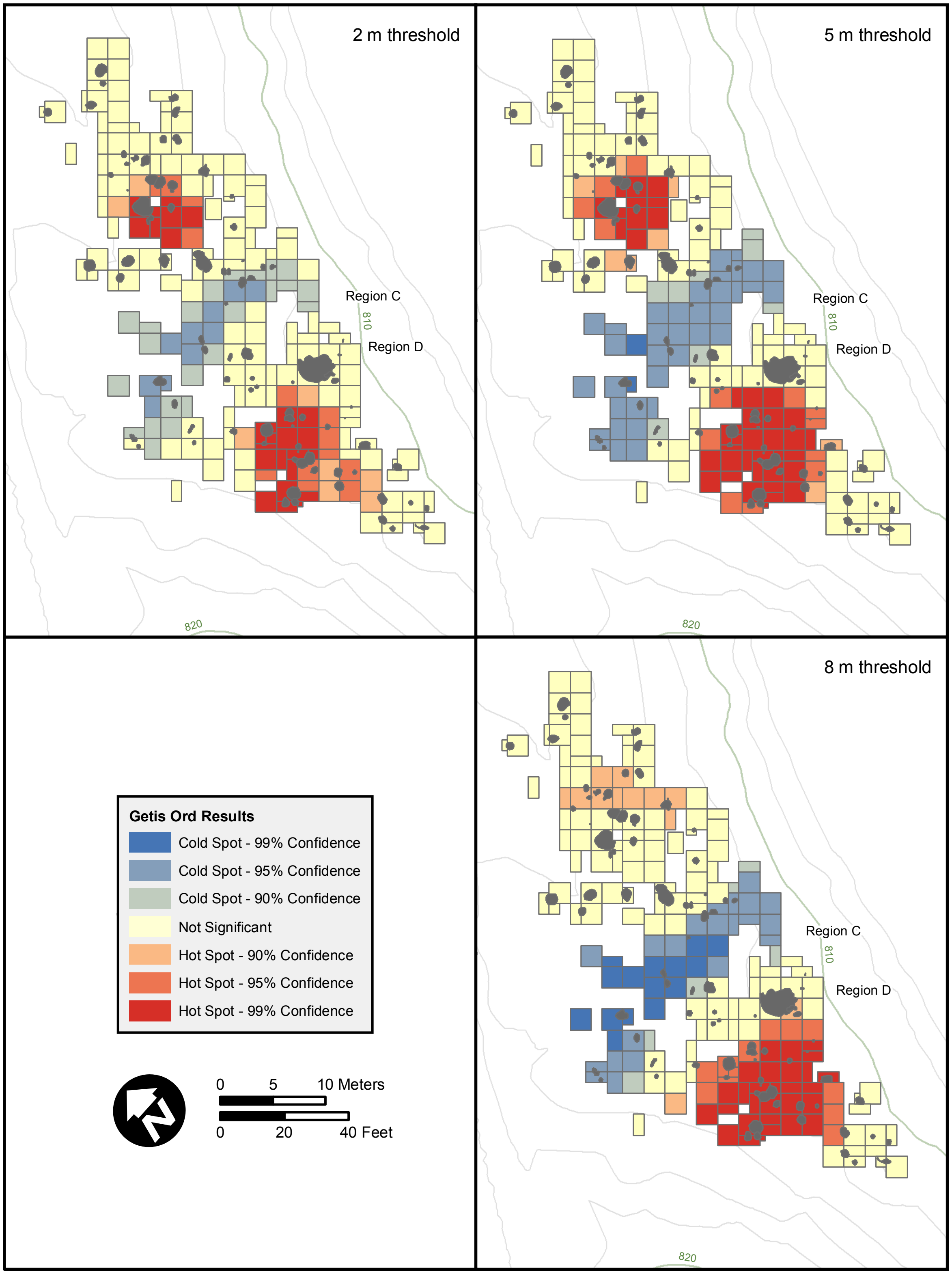
Results of the descriptive and spatial statistics for the Middle Woodland lithics in Regions C and D.



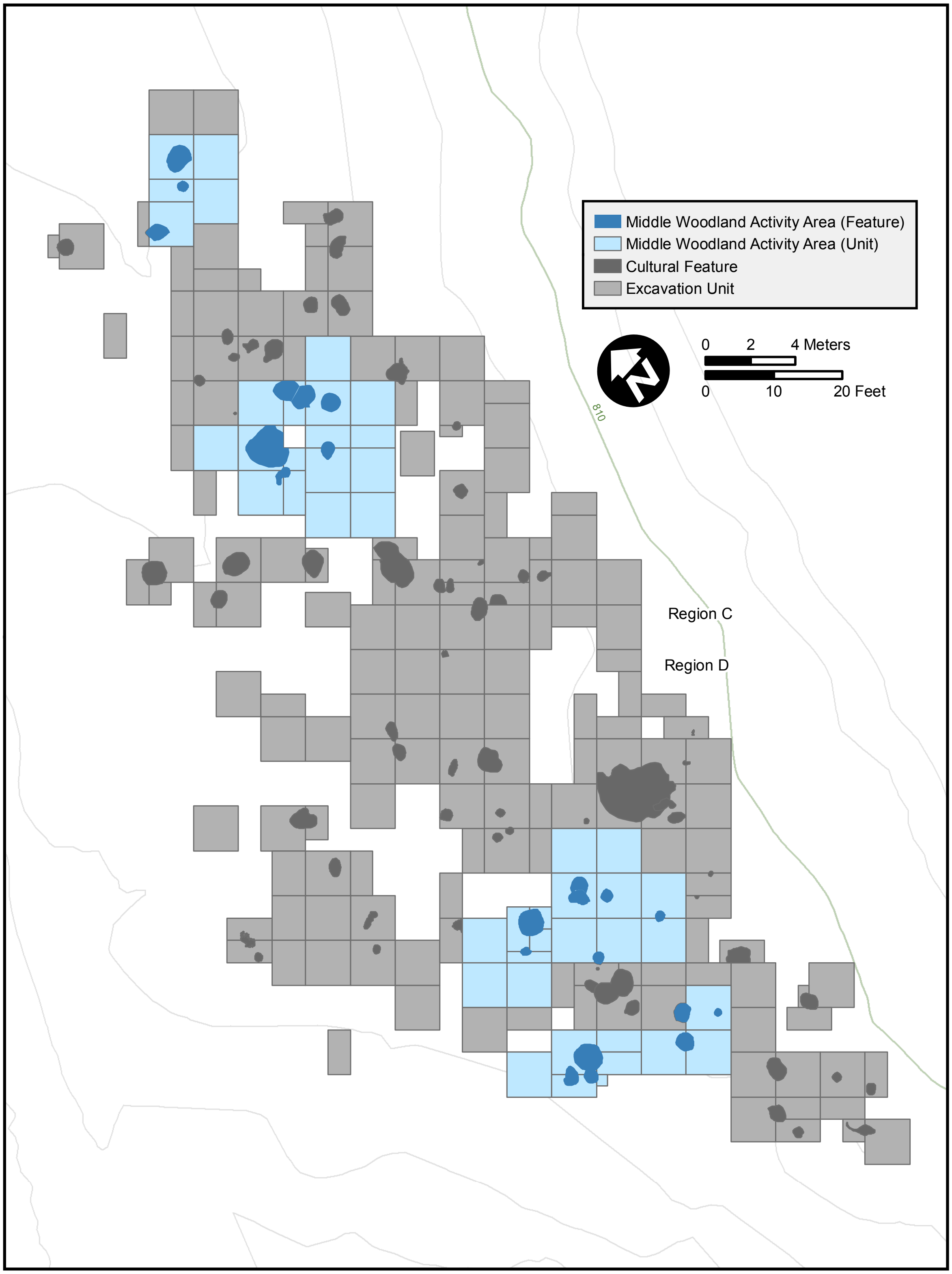
Results of the descriptive and spatial statistics for the Middle Woodland ceramics in Regions C and D.



Results of the Getis Ord Gi* statistic for the Middle Woodland lithics in Regions C and D.



Results of the Getis Ord Gi* statistic for the Middle Woodland ceramics in Regions C and D.



Activity area associated with the Middle Woodland component in Regions C and D.

Appendix C. Raw Material Profiles of the Early and Middle Woodland Components

Early Woodland Raw Materials

Description	Waste Flakes	Core/Core Tool	Flake Tool	Formal Tool	Diagnostic Formal Tool	Total Count	Percent
Local Source							
Galena Chert	11453	28	246	113	49	11889	95.15
Prairie du Chien Chert	95	0	4	3	9	111	0.89
Silurian	134	0	4	1	0	139	1.11
Quartz/Quartzite	6	1	0	0	0	7	0.06
Sedimentary Rock						0	0.00
Igneous	2	0	0	0	0	2	0.02
Subtotal Local	11690	29	254	117	58	12148	97.22
Non-Local						0	0.00
Burlington	251	1	16	13	4	285	2.28
Chalcedony	8	0	0	0	0	8	0.06
Cochrane	9	0	0	0	0	9	0.07
Dongola	1	0	0	0	0	1	0.01
Knife River Flint	3	0	0	0	0	3	0.02
Maquoketa	7	0	0	0	0	7	0.06
Orthoquartzite	17	0	0	0	0	17	0.14
Wyandotte	14	0	3	0	0	17	0.14
Subtotal Non Local	310	1	19	13	4	347	2.78
Grand Total	12000	30	273	130	62	12495	100.00

Middle Woodland Raw Materials

Description	Waste Flakes	Core/ Core Tool	Flake Tool	Formal Tool	Diagnostic Formal Tool	Total Count	Percent
Local Source							
Galena Chert	13791	15	307	100	9	14222	94.04
Prairie du Chien Chert	71		6	3	6	86	0.57
Silurian	386		3	6		395	2.61
Quartz/Quartzite	1					1	0.01
Sedimentary Rock	1					1	0.01
Igneous	1					1	0.01
Subtotal Local	14251	15	316	109	15	14706	97.24
Non-Local						0	0.00
Burlington	286		41	7	9	343	2.27
Chalcedony	2					2	0.01
Cochrane	1	1				2	0.01
Dongola						0	0.00
Knife River Flint	1					1	0.01
Maquoketa	7					7	0.05
Orthoquartzite	22					22	0.15
Wyandotte	39		2			41	0.27
Subtotal Non Local	358	1	43	7	9	418	2.76
Total	14609	16	359	116	24	15124	100.00

Appendix D. Photographs and Rim Profiles of the Early and Middle Woodland Vessel Assemblage

Vessel 1048 Douglass Net-Marked

Vessel 2001 Havana Zoned

Vessel 2002 Havana Zoned

Vessel 2003 Lake Nokomis Trailed

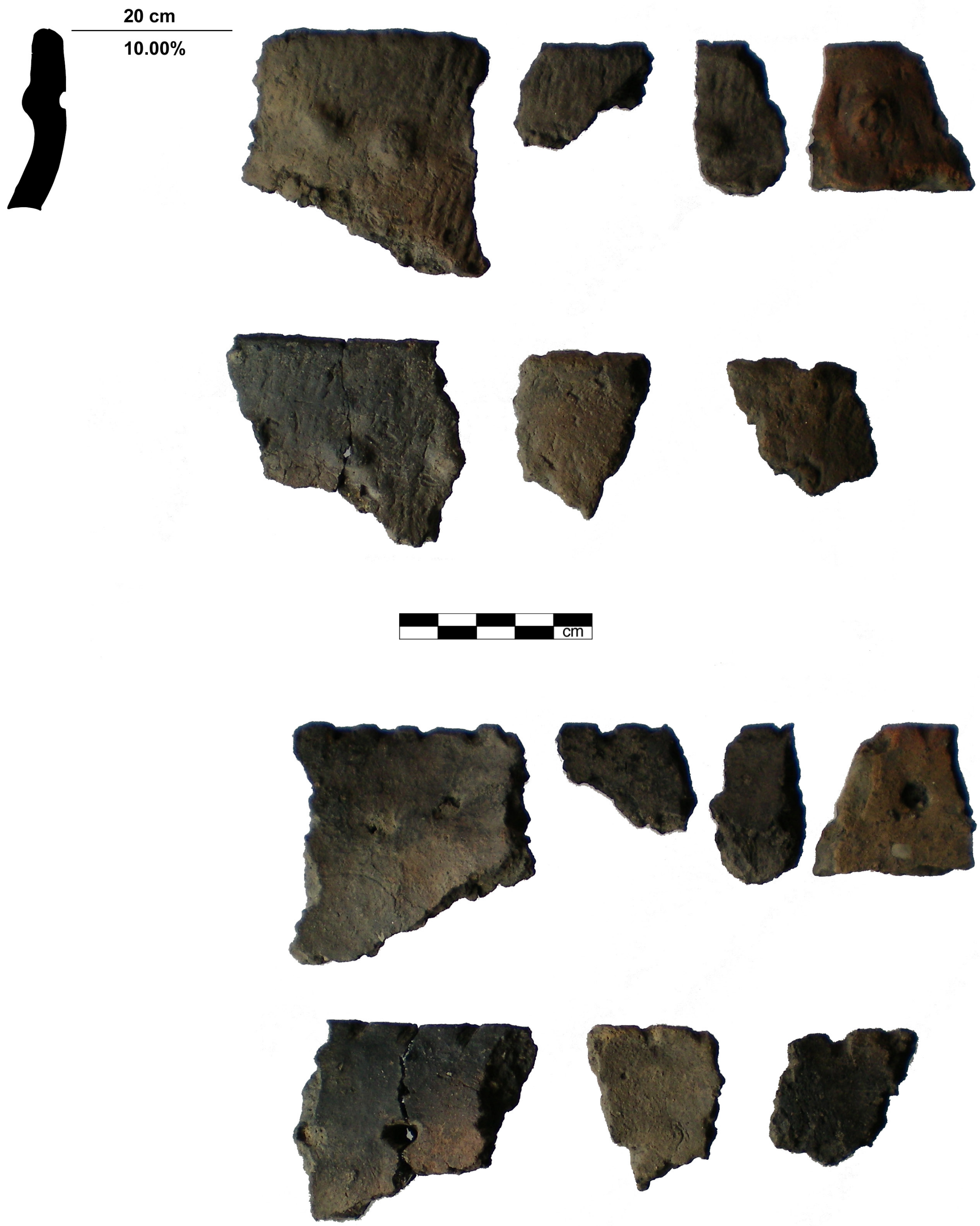
Vessel 2004 Naples Stamped

Vessel 2005 Havana Ware


Indeterminate diameter
<5.00%
cm

Vessel 2007 Kegonsa Stamped

Vessel 2008 Kegonsa Stamped



Vessel 2009 Naples Stamped

Vessel 2010 Kegonsa Stamped

Vessel 2013 Shorewood Cord-Roughened


16 cm
12.00%
cm

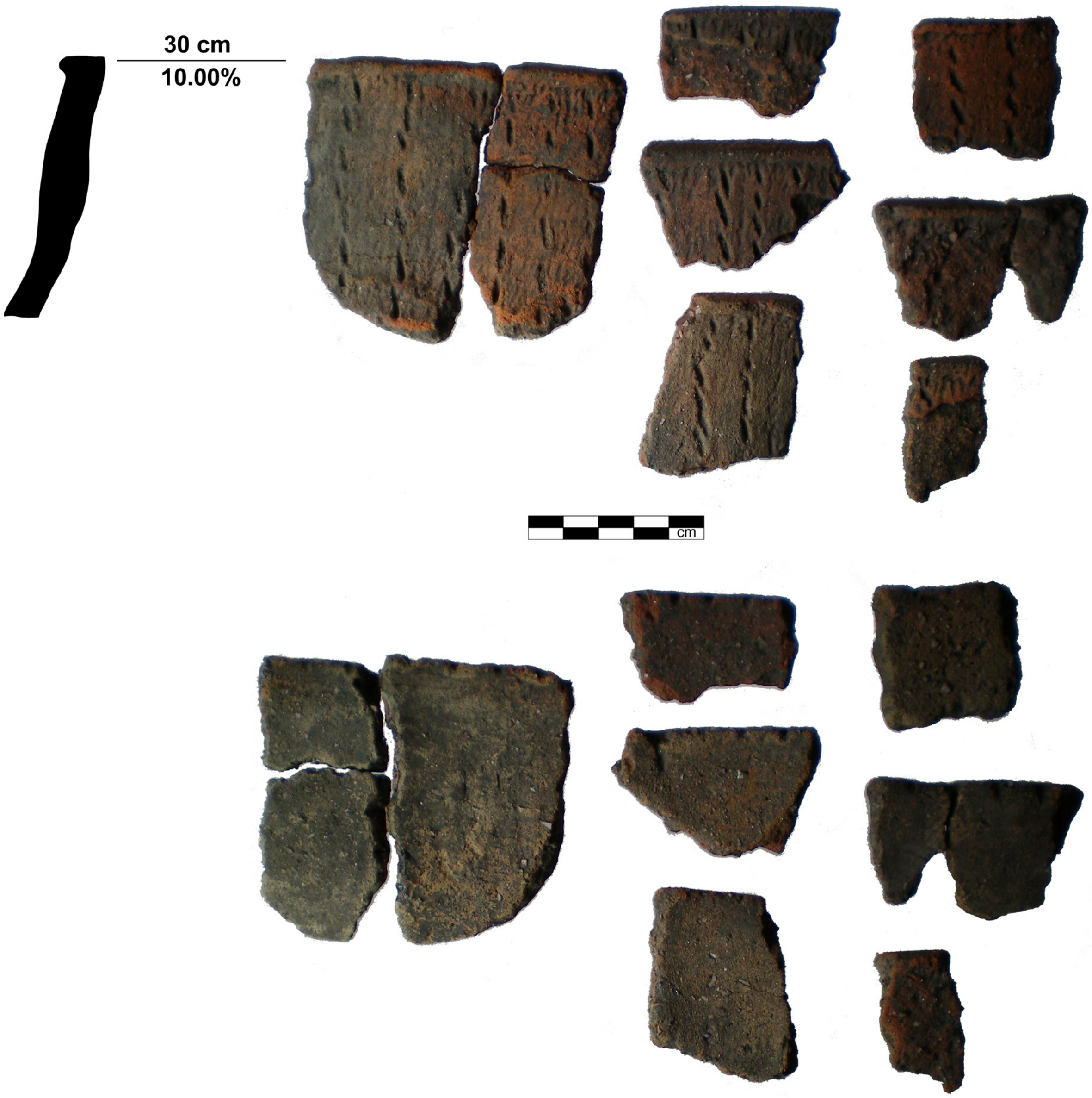
Vessel 2015 Shorewood Cord-Roughened

Vessel 2017 Shorewood Cord-Roughened

Vessel 2018 Shorewood Cord-Roughened

Vessel 2019 Deer Creek Incised

Vessel 2020 Naples Stamped



Vessel 2022 Kegonsa Stamped

Vessel 2024 Kegonsa Stamped

Vessel 2025 Seed Jar

Vessel 2026 Shorewood Cord-Roghened

Vessel 2027 Shorewood Cord-Roughened

Vessel 2028 Shorewood Cord-Roughened

Vessel 2029 Shorewood Cord-Roughened

Vessel 2030 Shorewood Cord-Roughened

Vessel 2031 Shorewood Cord-Roughened

Vessel 2032 Shorewood Cord-Roughened


Indeterminate diameter
<5.00%
cm

Vessel 2035 Kegonsa Stamped

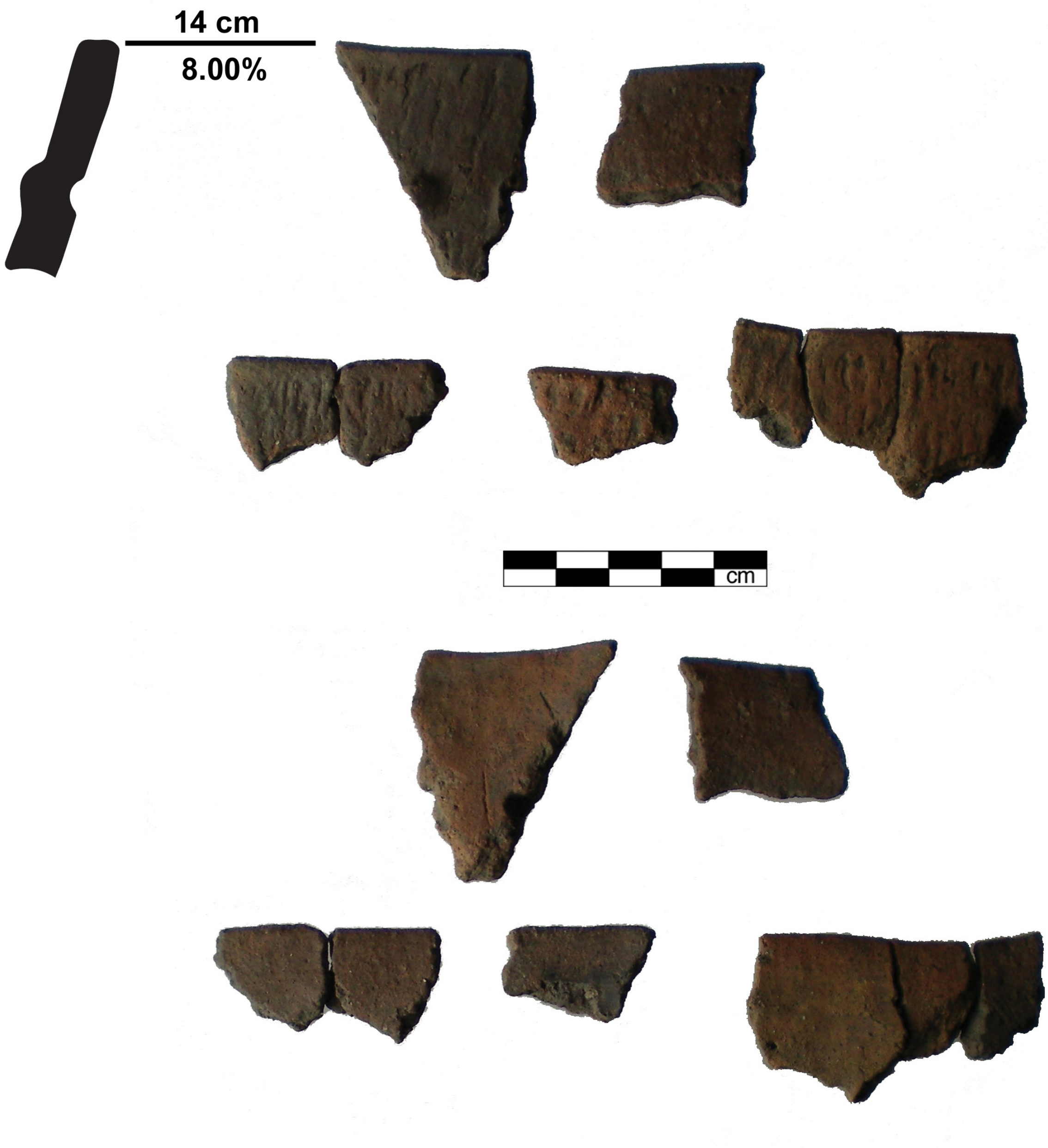
Vessel 2036 Shorewood Cord-Roughened

Vessel 2037 Kegonsa Stamped

Vessel 2038 Shorewood Cord-Roughened

Vessel 2039 Shorewood Cord-Roughened

Vessel 2040 Shorewood Cord-Roughened



Vessel 2041 Kegonsa Stamped

Vessel 2042 Havana Ware

Vessel 2043 Kegonsa Stamped

Vessel 3001 Dane Incised

Vessel 3002 Dane Incised

Vessel 3003 Dane Incised

Vessel 3004 Dane Incised

Vessel 3005 Dane Incised

Vessel 3006 Dane Incised

Vessel 3007 Dane Incised

Vessel 3008 Dane Incised

Vessel 3009 Dane Incised

Vessel 3010 Dane Incised

Vessel 3012 Dane Incised

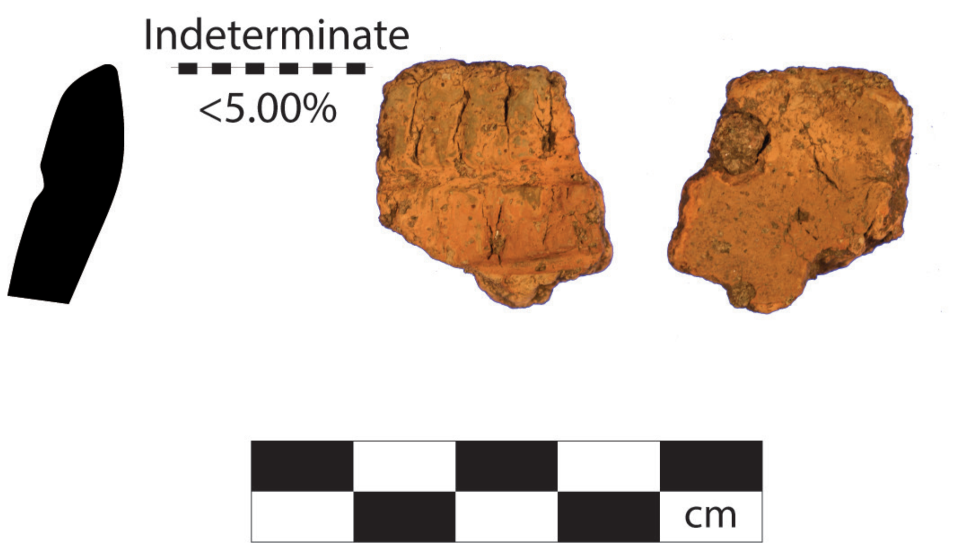
Vessel 3013 Dane Incised

Vessel 3015 Dane Incised

Vessel 3016 Dane Incised

Vessel 3018 Dane Incised

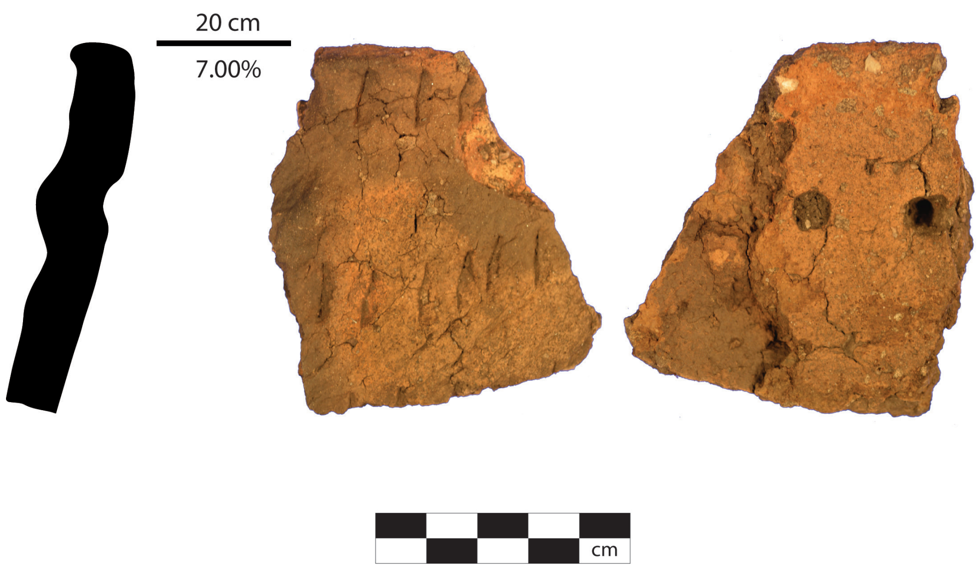
Vessel 3019 Dane Incised



Vessel 3020 Dane Incised

Vessel 3021 Dane Incised

Vessel 3022 Dane Punched



Vessel 3023 Shorewood Cord-Roughened

Vessel 3024 Kegonsa Stamped

Vessel 3025 Shorewood Cord-Roughened

Vessel 3026 Prairie Bossed

Vessel 3027 Shorewood Cord-Roughened

Vessel 3028 Prairie Corded Stamped

Vessel 3029 Prairie Bossed

Vessel 3030 Prairie Linear Stamped

Vessel 3032 Kegonsa Stamped

Vessel 3033 Kegonsa Stamped

Vessel 3034 Hopewell-Related Havana Ware

Vessel 3035 Dane Incised

Vessel 3036 Dane Incised


Indeterminate diameter
cm

Vessel 3038 Dane Incised

Appendix E. Vessel Attribute Data

Vessel	Typological Class	Vessel Form	Sherd Count	Sherd Weight (g)	Vesse Form Type	Rim Stance	Rim Shape	Lip Shape	Orifice Diam (cm)	Oriface Class	Thickness Class	Thickness (mm)	Paste Category	Oxidation Category	Temper	Surface Treatment Exterior	Surface Treatment Interior
1048	Douglass Net-Marked	Jar	4	53.73	Globular	Slightly everted	Folded	Rounded	20	1 Small-Medium	2-Thin	6.77	P2	OX2	Grit	Net-Marked	None
2001	Havana Zoned	Jar	7	117.35	Globular	Direct	Unmodified	Flattened	18	1 Small-Medium	2-Thin	7.85	P1	OX3	Grit	Smoothed over CM	None
2002	Havana Zoned	Jar	133	1109.47	Conoidal	Direct	Unmodified	Flattened	30	3 Medium-Large	1-Thick	9.77	P2	OX7	Grit	Smoothed over CM	None
2003	Shorewood Cord Roughened	Jar	39	578.45	Conoidal	Slightly inverted	Unmodified	Flattened	20	1 Small-Medium	2-Thin	7.67	P5	OX1	Grit	Cordmarked	None
2004	Naples Stamped	Jar	16	130.89	Conoidal	Slightly everted	Unmodified	Flattened	30	3 Medium-Large	1-Thick	9.25	P2	OX1	Grit	Cordmarked	None
2005	Havana Plain - Highsmith Plain	Jar	3	89.61	Conoidal	Direct	Unmodified	Flattened	20	1 Small-Medium	1-Thick	10.57	P2	OX4	Grit	Smoothed over CM	None
2006	Sister Creeks Punctate	Jar	55	56.32	Globular	Slightly everted	Pinched	Flattened	IND	IND	1-Thick	8.81	P2	OX7	Grit	Smoothed over CM	None
2007	Shorewood Cord Roughened	Jar	11	124.53	Conoidal	Slightly Inverted	Unmodified	Flattened	22	1 Small-Medium	1-Thick	11.47	P5	OX1	Grit	Cordmarked	None
2008	Kegonsa Stamped	Jar	7	127.83	Globular	Direct	Pinched	Flattened	20	1 Small-Medium	1-Thick	9.12	P2	OX7	Grit	Cordmarked	None
2009	Naples Stamped	Jar	15	79.97	Conoidal	Direct	Unmodified	Flattened & beveled to the exterior	44	4 Large	2-Thin	7.24	P6	OX1	Grit	Smoothed over CM	CWS on interior
2010	Kegonsa Stamped	Jar	16	130.2	Conoidal	inverted	Unmodified	Rounded	14	2 Small	2-Thin	7.05	P5	OX1	Grit	Cordmarked	None
2013	Shorewood Cord-Roughened	Jar	16	130.97	Conoidal	Slightly everted	Folded	Flattened	40	4 Large	1-Thick	8.81	P5	OX7	Grit	Cordmarked	None
2014	Shorewood Cord-Roughened	Jar	15	116.59	Conoidal	Slightly inverted	Unmodified	Rounded	16	1 Small-Medium	2-Thin	6.83	P2	OX2	Grit	Cordmarked	Smoothed
2015	Shorewood Cord-Roughened	Jar	2	49.11	Conoidal	Direct	Folded	Flattened	20	1 Small-Medium	1-Thick	9.76	P5	OX1	Grit	Cordmarked	None
2017	Shorewood Cord-Roughened	Jar	13	89.17	Conoidal	Direct	Unmodified	Flattened	IND	IND	1-Thick	11.19	P5	OX7	Grit	Cordmarked	None
2018	Shorewood Cord-Roughened - Highsmith Plain	Jar	4	59.71	Conoidal	Slightly inverted	Folded	Flattened	IND	IND	1-Thick	9.52	P2	OX2	Grit	Smoothed over CM	None
2019	Deer Creek Incised	Jar	84	773.87	Globular	Direct	Folded	Rounded	20	1 Small-Medium	2-Thin	7.39	P1	OX7	Grit	Cordmarked	None
2020	Naples Stamped	Jar	17	263	Conoidal	Direct	Folded	Flattened	30	3 Medium-Large	1-Thick	9.97	P4	OX1	Grit	Cordmarked	None
2022	Kegonsa Stamped	Jar	13	110.83	Conoidal	Everted	Pinched	Rounded	20	1 Small-Medium	2-Thin	7.52	P3	OX1	Grit	Cordmarked	None
2024	Kegonsa Stamped	Jar	2	15.4	Conoidal	Direct	Unmodified	Flattened	30	3 Medium-Large	2-Thin	7.86	P4	OX4	Grit	Cordmarked	Smoothed
2025	Seed Jar	Jar	1	4.08	Tecomate	Inverted	Pinched	Rounded	10	2 Small	2-Thin	7.19	P4	OX3	Grit	None	Smoothed
2026	Shorewood Cord-Roughened	Jar	1	20.56	Conoidal	Everted	Unmodified	Rounded to flattened	20	1 Small-Medium	2-Thin	7.8	P2	OX3	Grit	Smoothed over CM	Possible smoothed
2027	Shorewood Cord-Roughened	Jar	1	9.24	Conoidal	Slightly inverted	Unmodified	Flattened	IND	IND	2-Thin	7.31	P3	OX1	Grit	Cordmarked	Possible smoothed
2028	Shorewood Cord-Roughened	Jar	1	10.42	Conoidal	Direct	Folded	Flattened	10	2 Small	1-Thick	8.96	P2	OX1	Grit	Cordmarked	None
2029	Shorewood Cord-Roughened	Jar	1	8.28	Conoidal	Everted	Folded	Beveled (to exterior)	44	4 Large	1-Thick	9.75	P2	OX2	Grit	Cordmarked	Smoothed
2030	Shorewood Cord-Roughened	Jar	1	17.62	Conoidal	Direct	Folded	Flattened	IND	IND	1-Thick	8.58	P5	OX6	Grit	Cordmarked	Smoothed

Vessel	Typological Class	Vessel Form	Sherd Count	Sherd Weight (g)	Vesse Form Type	Rim Stance	Rim Shape	Lip Shape	Orifice Diam (cm)	Oriface Class	Thickness Class	Thickness (mm)	Paste Category	Oxidation Category	Temper	Surface Treatment Exterior	Surface Treatment Interior
2031	Shorewood Cord-Roughened - Highsmith Plain	Jar	1	8.3	Conoidal	Slightly everted	Pinched	Flattened	10	2 Small	1-Thick	9.55	P3	OX4	Grit	Cordmarked	Smoothed
2032	Shorewood Cord-Roughened	Jar	3	30.47	Conoidal	Direct	Folded	Flattened	30	3 Medium-Large	1-Thick	8.34	P3	OX1	Grit	Cordmarked	Possible smoothing
2033	Shorewood Cord-Roughened	Jar	2	7.95	Conoidal	Direct	Folded	Flattened	IND	IND	2-Thin	6.51	P5	OX1	Grit	Cordmarked	Smoothed
2035	Kegonsa Stamped	Jar	5	71.47	Conoidal	Slightly everted	Unmodified	Rounded	20	1 Small-Medium	1-Thick	8.94	P4	OX5	Grit	Cordmarked	None
2036	Shorewood Cord-Roughened	Jar	1	7.54	Conoidal	Direct	Folded	Flattened	IND	IND	1-Thick	8.835	P5	OX5	Grit	Cordmarked	IND
2037	Kegonsa Stamped	Jar	4	18.54	Conoidal	Everted	Unmodified	Rounded	46	4 Large	2-Thin	6.17	P4	OX1	Grit	Cordmarked	None
2038	Shorewood Cord-Roughened	Jar	11	95.42	Conoidal	Direct	Folded	Flattened but 1 rim has cm & crenulation	22	1 Small-Medium	1-Thick	9.86	P5	OX2	Grit	Cordmarked	Smoothed
2039	Shorewood Cord-Roughened	Jar	1	23.07	Conoidal	Slightly inverted	Folded	Flattened	30	3 Medium-Large	1-Thick	8.3	P5	OX7	Grit	Cordmarked	Smoothed
2040	Shorewood Cord-Roughened	Jar	8	54.19	Conoidal	Slightly inverted	Unmodified	Flattened	14	2 Small	2-Thin	7.15	P1	OX4	Grit	Smoothed over CM	Smoothed
2041	Kegonsa Stamped	Jar	1	12.28	Conoidal	Direct	Unmodified	Flattened	10	2 Small	1-Thick	8.25	P5	OX5	Grit	Cordmarked	Smoothed
2042	Havana Plain	Jar	1	2.81	Conoidal	inverted	Unmodified	Flattened				0	P1	OX1	Grit	over CM	IND
2043	Kegonsa Stamped	Jar	4	13.1	Conoidal	Direct	Folded	Flattened	18	1 Small-Medium	2-Thin	6.585	P2	OX3	Grit	Cordmarked	Smoothed
3001	Dane Incised	Jar	1	16.74	Conoidal	Direct	Unmodified	Flattened	28	3 Medium-Large	1-Thick	9.4	P3	OX4	Grit	Cordmarked	None
3002	Dane Incised	Jar	2	20.29	IND	Everted	Pinched	Rounded	16	1 Small-Medium	1-Thick	8.42	P5	OX3	Grit	Cordmarked	Smoothed
3003	Dane Incised	Jar	1	9.11	IND	Slightly everted	Thickened & Folded	Rounded			2-Thin	7.95	P3	OX2	Grit	Cordmarked	None
3004	Dane Incised	Jar	2	7.74	IND	Direct	Unmodified	Flattened	10	2 Small	2-Thin	6.66	P3	OX3	Grit	Cordmarked	None
3005	Dane Incised	Jar	19	125.16	IND	Direct	Unmodified	Flattened - Crenulated	20	1 Small-Medium	1-Thick	9.44	P5	OX7	Grit	Cordmarked	None
3006	Dane Incised	Jar	7	28.69	Globular	Everted	Pinched	Rounded - crenulated	10	2 Small	2-Thin	7.83	P3	OX6	Grit	Cordmarked	None
3007	Dane Incised	Jar	20	250.36	Conoidal	Slightly everted	Unmodified & Folded	Flattened	30	3 Medium-Large	1-Thick	9.15	P3	OX7	Grit	Cordmarked	Smoothed
3008	Dane Incised	Jar	5	129.02	Conoidal	Direct	Thickened	Flattened	18	1 Small-Medium	1-Thick	9.4	P3	OX4	Grit	Cordmarked	Smoothed
3009	Dane Incised	Jar	23	102.78	IND	Direct	Pinched	Flattened			2-Thin	6.36	P3	OX7	Grit	Cordmarked	None
3010	Dane Incised	Jar	3	27.83	Globular	Direct	Unmodified	Flattened	16	1 Small-Medium	2-Thin	5.36	P3	OX5	Grit	Cordmarked	Smoothed
3012	Dane Incised	Jar	6	48.4	Globular	Slightly everted	Pinched	Rounded	20	1 Small-Medium	1-Thick	8.45	P5	OX1	Grit	Cordmarked	Smoothed
3013	Dane Incised	Jar	12	109.31	Globular	Direct	Unmodified	Flattened	20	1 Small-Medium	1-Thick	8.72	P3	OX2	Grit	Cordmarked	None
3015	Dane Incised	Jar	71	261.95	Conoidal	Direct	Unmodified	Rounded - crenulated	IND	IND	2-Thin	7.56	P3	OX7	Grit	Cordmarked	None
3016	Dane Incised	Jar	10	98.17	Conoidal	Everted	Unmodified & Folded	Flattened	14	2 Small	2-Thin	7.79	P3	OX1	Grit	Cordmarked	None
3018	Dane Incised	Jar	21	294.72	Globular	Slightly everted	Unmodified & Folded	Flattened	14	2 Small	2-Thin	7.25	P5	OX2	Grit	Cordmarked	Smoothed
3019	Dane Incised	Jar	1	4.06	Globular	Direct	Pinched	Beveled	IND	IND	2-Thin	6.69	P5	OX2	Grit	Cordmarked	None

Vessel	Typological Class	Vessel Form	Sherd Count	Sherd Weight (g)	Vesse Form Type	Rim Stance	Rim Shape	Lip Shape	Orifice Diam (cm)	Oriface Class	Thickness Class	Thickness (mm)	Paste Category	Oxidation Category	Temper	Surface Treatment Exterior	Surface Treatment Interior
3020	Dane Incised	Jar	1	2.58	IND	Direct	Thickened	Flattened	IND	IND	2-Thin	5.26	P3	OX2	Grit	Cordmarked	None
3021	Dane Incised	Jar	11	598.96	Subconoidal	Everted	Unmodified	Rounded	30	3 Medium-Large	1-Thick	13.26	P5	OX1	Grit	Cordmarked	None
3022	Dane Punched	Jar	34	566.87	Subconoidal	Direct	Unmodified	Rounded	20	1 Small-Medium	1-Thick	9.35	P6	OX7	Grit	Cordmarked	None
3023	Kegonsa Stamped	Jar	8	83.81	Conoidal	Everted	Folded	Flattened	32	3 Medium-Large	1-Thick	8.34	P5	OX3	Grit	Cordmarked	Smoothed
3024	Kegonsa Stamped	Jar	15	171.39	Globular	everted	Folded	Flattened	10	2 Small	2-Thin	7.91	P5	OX2	Grit	Cordmarked	None
3025	Shorewood Cord-Roughened	Jar	1	44.85	Conoidal	Slightly inverted	Unmodified	Flattened	IND	IND	1-Thick	11.02	P5	OX3	Grit	Cordmarked	Possible smoothed over cord marking
3026	Prairie Bossed	Jar	1	12.75	IND	Slightly everted	Pinched	Rounded	16	1 Small-Medium	1-Thick	8.22	P2	OX1	Sand	Smoothed-Over	None
3027	Shorewood Cord-Roughened	Jar	5	53.39	Conoidal	Direct	Folded	Flattened	10	2 Small	1-Thick	9.33	P5	OX4	Grit	Cordmarked	None
3028	Prairie Corded Stamped	Jar	2	2.45	IND	Direct	Unmodified	Flattened	IND	IND	2-Thin	4.53	P2	OX1	Sand	Smoothed-Over	None
3029	Prairie Bossed	Jar	2	7.54	IND	Slightly everted	Unmodified & Folded	Flattened	IND	IND	2-Thin	4.04	P5	OX1	Sand	Cordmarked	None
3030	Prairie Linear Stamped	Jar	1	9.19	IND	Direct	Pinched	Rounded	18	1 Small-Medium	2-Thin	6.35	P1	OX1	Sand	Cordmarked	None
3032	Kegonsa Stamped	Jar	2	36.85	Conoidal	Everted	Pinched	Rounded - Crenulated	IND	IND	1-Thick	9.41	P3	OX2	Grit	Cordmarked	Smoothed
3033	Kegonsa Stamped	Jar	4	33.76	Conoidal	Direct	Unmodified	Beveled - Crenulated	IND	IND	1-Thick	8.87	P6	OX1	Grit	Cordmarked	None
3034	Hopewell-Related	Jar	5	37.12	Subconoidal	Everted	Folded	Rounded	16	1 Small-Medium	2-Thin	6.97	P1	OX1	Grit	Smoothed over CM	None
3035	Dane Incised	Jar	5	3.48	IND	Slightly everted	Thickened & Folded	Flattened	IND	IND	2-Thin	5.72	P3	OX7	Grit	Cordmarked	None
3036	Dane Incised	Jar	7	38.04	Globular	Direct	Pinched	Flattened	20	1 Small-Medium	2-Thin	6.57	P3	OX2	Grit	Cordmarked	Smoothed
3037	Dane Incised	Jar	7	80.01	IND	Direct	Thickened	Beveled	IND	IND	1-Thick	8.6	P5	OX2	Grit	Cordmarked	None
3038	Dane Incised	Jar	2	37.04	Conoidal	Direct	Unmodified	Flattened	10	2 Small	1-Thick	10.09	P5	OX3	Grit	Cordmarked	One sherd looks cordmarked

Appendix F. Vessel Data Used for Intended Function - Multiple Correspondence Analysis

Vessel	Association	Jar Form	Size Class	Rim Stance	Thickness	Surface Treatment Exterior	Surface Treatment Interior	Temper
1048	Middle Woodland	Globular	1 Small-Medium	Slightly everted	2-Thin	Net-Marked	None	Crushed granite
2001	Middle Woodland	Globular	1 Small-Medium	Direct	2-Thin	Smoothed over CM	None	Crushed granite
2002	Middle Woodland	Conoidal	3 Medium-Large	Direct	1-Thick	Smoothed over CM	None	Granite/feldspar
2003	Middle Woodland	Conoidal	1 Small-Medium	Slightly inverted	2-Thin	Cordmarked	None	Granite/pebbles
2004	Middle Woodland	Conoidal	3 Medium-Large	Slightly everted	1-Thick	Cordmarked	None	Granite/feldspar
2005	Middle Woodland	Conoidal	1 Small-Medium	Direct	1-Thick	Smoothed over CM	None	Crushed granite
2006	Middle Woodland	Globular		Slightly everted	1-Thick	Smoothed over CM	None	Crushed granite
2007	Middle Woodland	Conoidal	1 Small-Medium	Slightly Inverted	1-Thick	Cordmarked	None	Granite/feldspar
2008	Middle Woodland	Globular	1 Small-Medium	Direct	1-Thick	Cordmarked	None	Crushed granite
2009	Middle Woodland	Conoidal	4 Large	Direct	2-Thin	Smoothed over CM	CWS on interior	Granite/pebbles
2010	Middle Woodland	Conoidal	2 Small	Slightly inverted	2-Thin	Cordmarked	None	Granite/Mafic
2013	Middle Woodland	Conoidal	4 Large	Slightly everted	1-Thick	Cordmarked	None	Granite/pebbles
2014	Middle Woodland	Conoidal	1 Small-Medium	Slightly inverted	2-Thin	Cordmarked	Smoothed	Crushed granite
2015	Middle Woodland	Conoidal	1 Small-Medium	Direct	1-Thick	Cordmarked	None	Granite/feldspar
2017	Middle Woodland	Conoidal		Direct	1-Thick	Cordmarked	None	Crushed granite
2018	Middle Woodland	Conoidal		Slightly inverted	1-Thick	Smoothed over CM	None	Granite/feldspar
2019	Middle Woodland	Globular	1 Small-Medium	Direct	2-Thin	Cordmarked	None	Crushed granite
2020	Middle Woodland	Conoidal	3 Medium-Large	Direct	1-Thick	Cordmarked	None	Granite/feldspar
2029	Middle Woodland	Conoidal	4 Large	Everted	1-Thick	Cordmarked	Smoothed	Crushed granite
2030	Middle Woodland	Conoidal		Direct	1-Thick	Cordmarked	Smoothed	Crushed granite
2031	Middle Woodland	Conoidal	2 Small	Slightly everted	1-Thick	Cordmarked	Smoothed	Granite/pebbles
2032	Middle Woodland	Conoidal	3 Medium-Large	Direct	1-Thick	Cordmarked	Possible smoothing	Granite/pebbles
2033	Middle Woodland	Conoidal		Direct	2-Thin	Cordmarked	Smoothed	Granite/feldspar
2028	Middle Woodland	Conoidal	2 Small	Direct	1-Thick	Cordmarked	None	Crushed granite

Vessel	Association	Jar Form	Size Class	Rim Stance	Thickness	Surface Treatment Exterior	Surface Treatment Interior	Temper
2035	Middle Woodland	Conoidal	1 Small-Medium	Slightly everted	1-Thick	Cordmarked	None	Crushed granite
2036	Middle Woodland	Conoidal		Direct	1-Thick	Cordmarked	Indeterminate	Granite/feldspar
2037	Middle Woodland	Conoidal	4 Large	Everted	2-Thin	Cordmarked	None	Granite/Mafic
2038	Middle Woodland	Conoidal	1 Small-Medium	Direct	1-Thick	Cordmarked	Smoothed	Granite/pebbles
2039	Middle Woodland	Conoidal	3 Medium-Large	Slightly inverted	1-Thick	Cordmarked	Smoothed	Granite/pebbles
2040	Middle Woodland	Conoidal	2 Small	Slightly inverted	2-Thin	Smoothed over CM	Smoothed	Crushed granite
2041	Middle Woodland	Conoidal	2 Small	Direct	1-Thick	Cordmarked	Smoothed	Crushed granite
2042	Middle Woodland	Conoidal		Slightly inverted		Smoothed over CM	Indeterminate	Crushed granite
2043	Middle Woodland	Conoidal	1 Small-Medium	Direct	2-Thin	Cordmarked	Smoothed	Crushed granite
3001	Early Woodland	Conoidal	3 Medium-Large	Direct	1-Thick	Cordmarked	None	Crushed granite
3002	Early Woodland	Indeterminate	1 Small-Medium	Everted	1-Thick	Cordmarked	Smoothed	Crushed granite
3003	Early Woodland	Indeterminate		Slightly everted	2-Thin	Cordmarked	None	Crushed granite
3004	Early Woodland	Indeterminate	2 Small	Direct	2-Thin	Cordmarked	None	Crushed granite
3005	Early Woodland	Indeterminate	1 Small-Medium	Direct	1-Thick	Cordmarked	None	Crushed granite
3006	Early Woodland	Globular	2 Small	Everted	2-Thin	Cordmarked	None	Crushed granite
3007	Early Woodland	Conoidal	3 Medium-Large	Slightly everted	1-Thick	Cordmarked	Smoothed	Granite/pebbles
3008	Early Woodland	Conoidal	1 Small-Medium	Direct	1-Thick	Cordmarked	Smoothed	Crushed granite
3009	Early Woodland	Indeterminate		Direct	2-Thin	Cordmarked	None	Crushed granite
3010	Early Woodland	Globular	1 Small-Medium	Direct	2-Thin	Cordmarked	Smoothed	Crushed granite
3012	Early Woodland	Globular	1 Small-Medium	Slightly everted	1-Thick	Cordmarked	Smoothed	Crushed granite
3013	Early Woodland	Globular	1 Small-Medium	Direct	1-Thick	Cordmarked	None	Crushed granite
3015	Early Woodland	Conoidal		Direct	2-Thin	Cordmarked	None	Crushed granite
3016	Early Woodland	Conoidal	2 Small	Everted	2-Thin	Cordmarked	None	Crushed granite
3018	Early Woodland	Globular	2 Small	Slightly everted	2-Thin	Cordmarked	Smoothed	Granite/feldspar
3019	Early Woodland	Globular		Direct	2-Thin	Cordmarked	None	Crushed granite
2028	Middle Woodland	Conoidal	2 Small	Direct	1-Thick	Cordmarked	None	Crushed granite

Vessel	Association	Jar Form	Size Class	Rim Stance	Thickness	Surface Treatment Exterior	Surface Treatment Interior	Temper
3020	Early Woodland	Indeterminate		Direct	2-Thin	Cordmarked	None	Crushed granite
3021	Early Woodland	Subconoidal	3 Medium-Large	Everted	1-Thick	Cordmarked	None	Granite/feldspar
3022	Early Woodland	Subconoidal	1 Small-Medium	Direct	1-Thick	Cordmarked	None	Crushed granite
3023	Middle Woodland	Conoidal	3 Medium-Large	Everted	1-Thick	Cordmarked	Smoothed	Crushed granite
3024	Middle Woodland	Globular	2 Small	Slightly everted	2-Thin	Cordmarked	None	Granite/pebbles
3025	Middle Woodland	Conoidal		Slightly inverted	1-Thick	Cordmarked	Possible smoothed over cord marking	Crushed granite
3026	Early Woodland	Indeterminate	1 Small-Medium	Slightly everted	1-Thick	Smoothed-Over	None	Sand/pebbles
3027	Middle Woodland	Conoidal	2 Small	Direct	1-Thick	Cordmarked	None	Granite/pebbles
3028	Early Woodland	Indeterminate		Direct	2-Thin	Smoothed-Over	None	Sand
3029	Early Woodland	Indeterminate		Slightly everted	2-Thin	Cordmarked	None	Sand/pebbles
3030	Early Woodland	Indeterminate	1 Small-Medium	Direct	2-Thin	Cordmarked	None	Sand
3032	Middle Woodland	Conoidal		Everted	1-Thick	Cordmarked	Smoothed	Crushed granite
3033	Middle Woodland	Conoidal		Direct	1-Thick	Cordmarked	None	Granite/pebbles
3034	Middle Woodland	Subconoidal	1 Small-Medium	Everted	2-Thin	Smoothed over CM	None	Crushed granite
3035	Early Woodland	Indeterminate		Slightly everted	2-Thin	Cordmarked	None	Crushed granite
3036	Early Woodland	Globular	1 Small-Medium	Direct	2-Thin	Cordmarked	Smoothed	Crushed granite
3037	Early Woodland	Indeterminate		Direct	1-Thick	Cordmarked	None	Crushed granite
3038	Early Woodland	Conoidal	2 Small	Direct	1-Thick	Cordmarked	One sherd looks cordmarked	Crushed granite
2022	Middle Woodland	Conoidal	1 Small-Medium	Everted	2-Thin	Cordmarked	None	Granite/feldspar
2024	Middle Woodland	Conoidal	3 Medium-Large	Direct	2-Thin	Cordmarked	Smoothed	Crushed granite
2025	Middle Woodland	Tecomate/Seed	2 Small	Inverted	2-Thin	None	Smoothed	Crushed granite
2026	Middle Woodland	Conoidal	1 Small-Medium	Everted	2-Thin	Smoothed over CM	Possible smoothed	Crushed granite
2027	Middle Woodland	Conoidal		Slightly inverted	2-Thin	Cordmarked	Possible smoothed	Granite/feldspar
2028	Middle Woodland	Conoidal	2 Small	Direct	1-Thick	Cordmarked	None	Crushed granite

Appendix G. Group A Vessel Data Used for the Correspondence Analysis

Group A Vessel Data Set (All Vessels with Use Wear, n=28)

Vessel	Vessel Portion	Association	Interior	Exterior	Ware	Linear Tool
1048	Rim & Body	Middle Woodland	INT4	EXT0	MW Local	Present
2001	Rim & Body	Middle Woodland	INT1	EXT3	MW Havana	Absent
2002	Rim & Body	Middle Woodland	INT2	EXT2	MW Havana	Absent
2003	Rim & Body	Middle Woodland	INT2	EXT2	MW Local	Present
2004	Rim & Body	Middle Woodland	INT3	EXT1	MW Havana	Present
2005	Rim & Body	Middle Woodland	INT3	EXT1	MW Havana	Present
2006	Rim & Body	Middle Woodland	INT1	EXT3	MW Havana	Present
2007	Rim & Body	Middle Woodland	INT0	EXT0	MW Local	Present
2008	Rim & Body	Middle Woodland	INT1	EXT1	MW Local	Present
2010	Rim & Body	Middle Woodland	INT0	EXT0	MW Local	Present
2013	Rim & Body	Middle Woodland	INT0	EXT0	MW Local	Present
2019	Rim & Body	Middle Woodland	INT1	EXT1	MW Local	Present
2020	Rim & Body	Middle Woodland	INT0	EXT0	MW Havana	Present
2022	Rim & Body	Middle Woodland	INT0	EXT0	MW Local	Present
2026	Rim & Body	Middle Woodland	INT2	EXT2	MW Local	Present
2035	Rim & Body	Middle Woodland	INT1	EXT1	MW Local	Present
3006	Rim & Body	Early Woodland	INT3	EXT1	EW-IOCM	Present
3007	Rim & Body	Early Woodland	INT2	EXT3	EW-IOCM	Absent
3008	Rim & Body	Early Woodland	INT4	EXT1	EW-IOCM	Present
3009	Rim & Body	Early Woodland	INT4	EXT0	EW-IOCM	Present
3012	Rim & Body	Early Woodland	INT0	EXT0	EW-IOCM	Present
3015	Rim & Body	Early Woodland	INT4	EXT2	EW-IOCM	Present
3016	Rim & Body	Early Woodland	INT0	EXT0	EW-IOCM	Present
3018	Rim & Body	Early Woodland	INT1	EXT2	EW-IOCM	Present
3021	Rim & Body	Early Woodland	INT2	EXT2	EW-IOCM	Present
3022	Rim & Body	Early Woodland	INT2	EXT2	EW-IOCM	Absent
3025	Rim & Body	Middle Woodland	INT4	EXT0	MW Local	Absent
3034	Rim & Body	Middle Woodland	INT2	EXT3	MW Local	Absent

Group A Vessel Data Set (All Vessels with Sooting, n=21)

Vessel	Vessel Portion	Association	UseWearPresent	Int Use Wear Code	Ext Use Wear Code
2008	Rim & Body	Middle Woodland	Present	INT1	EXT1
2019	Rim & Body	Middle Woodland	Present	INT1	EXT1
2035	Rim & Body	Middle Woodland	Present	INT1	EXT1
3018	Rim & Body	Early Woodland	Present	INT1	EXT2
2001	Rim & Body	Middle Woodland	Present	INT1	EXT3
2006	Rim & Body	Middle Woodland	Present	INT1	EXT3
2002	Rim & Body	Middle Woodland	Present	INT2	EXT2
2003	Rim & Body	Middle Woodland	Present	INT2	EXT2
2026	Rim & Body	Middle Woodland	Present	INT2	EXT2
3021	Rim & Body	Early Woodland	Present	INT2	EXT2
3022	Rim & Body	Early Woodland	Present	INT2	EXT2
3007	Rim & Body	Early Woodland	Present	INT2	EXT3
3034	Rim & Body	Middle Woodland	Present	INT2	EXT3
2004	Rim & Body	Middle Woodland	Present	INT3	EXT1
2005	Rim & Body	Middle Woodland	Present	INT3	EXT1
3006	Rim & Body	Early Woodland	Present	INT3	EXT1
1048	Rim & Body	Middle Woodland	Present	INT4	EXT0
3009	Rim & Body	Early Woodland	Present	INT4	EXT0
3025	Rim & Body	Middle Woodland	Present	INT4	EXT0
3008	Rim & Body	Early Woodland	Present	INT4	EXT1
3015	Rim & Body	Early Woodland	Present	INT4	EXT2

Appendix H. Samples Submitted for Chemical Residue Analysis

Sample Number	Vessel	Association	Type	Ware	Reference
17UWM1	3021	Early Woodland	Dane Incised	Undefined	Malainey and Figol 2017
17UWM2	2002	Middle Woodland (Havana)	Havana Zoned	Havana Ware	Malainey and Figol 2017
17UWM3	3022	Early Woodland	Dane Punched	Outlet Ware	Malainey and Figol 2017
17UWM4	2019	Middle Woodland (Local)	Deer Creek Incised	Undefined	Malainey and Figol 2019
18UWM1	3018	Early Woodland	Dane Incised	Undefined	Malainey and Figol 2019
18UWM2	3007	Early Woodland	Dane Incised	Undefined	Malainey and Figol 2019
18UWM3	3015	Early Woodland	Dane Incised	Undefined	Malainey and Figol 2019
18UWM4	2014	Middle Woodland (Local)	Shorewood Cord-Roughened	Undefined	Malainey and Figol 2019
18UWM5	2003	Middle Woodland (Local)	Shorewood Cord Roughened	Undefined	Malainey and Figol 2019
18UWM6	2017	Middle Woodland (Local)	Shorewood Cord-Roughened	Undefined	Malainey and Figol 2019
18UWM7	2004	Middle Woodland (Havana)	Naples Stamped	Havana Ware	Malainey and Figol 2019
18UWM8	2001	Middle Woodland (Havana)	Havana Zoned	Havana Ware	Malainey and Figol 2019
18UWM9	3034	Middle Woodland (Havana)	Hopewell-Related	Havana Ware	Malainey and Figol 2019

Appendix I. Summary Results of Chemical Residue Analysis

Sample Number	Vessel	LIPID: Simple Category	LIPID: Category	LIPID: Fatty Acid	LIPID: Biomarker	LIPID: Plant Type	LIPID: Animal Type
17UWM1	3021	IND: Plant & Animal markers	No Lipid - Animal & Plant Markers	None detected	Cholesterol, Sterol	Present - Indeterminate	Present - Indeterminate
17UWM2	2002	Herbivore & Plant	Large herbivore & marbled & Plants	Animal & plant sterols	Cholesterol, Sterol	Present - Indeterminate	Large Lean Herbivore
17UWM3	3022	Herbivore only	Lean large herbivore	Lean large herbivore	None	None	Large Lean Herbivore
17UWM4	2019	Herbivore & Plant	Lean large herbivore & plants	Lean large herbivore	None	Present - Indeterminate	Large Lean Herbivore
18UWM1	3018	Herbivore & Plant	Large lean herbivore with plant roots	Large herbivore & other foods	Plant sterol	Plant roots	Large Lean Herbivore
18UWM2	3007	Plant & Animal: Medium Fat Content	Medium Fat Content	Medium fat content	Plant sterol	Medium Fat	Medium Fat
18UWM3	3015	Herbivore & Plant	Large herbivore & Medium Fat Content Foods	Large herbivore & other foods	Plant & animal sterol	Medium Fat	Large Lean Herbivore
18UWM4	2014	Herbivore & Plant	Large lean herbivore with plant roots	Large herbivore & other foods	Plant sterol; animal sterol	Plant roots	Large Lean Herbivore
18UWM5	2003	Herbivore & Plant	Large herbivore & low fat content plants	Large herbivore & other foods	Animal sterol	Low Fat	Large Lean Herbivore
18UWM6	2017	Decomposed Nut Oil & Animal Product	Decomposed nut oil and other foods	Decomposed nut oil, animal products (large herbvore), low fat content plants	Animal & Plant	Nuts & Lot Fat Content	Large Lean Herbivore
18UWM7	2004	Herbivore & Plant	Complex compositon; large herbivore products & plants	Large herbivore bone marrow and low fat conent plant OR large herbivore & medium/low fat content plants	Plant sterol; animal sterol	Low or Medium Fat	Large Lean Herbivore Marrow
18UWM8	2001	Herbivore & Plant	Large lean herbivore with plant roots	arge herbivore & other foods	Plant sterol; animal sterol	Plant roots	Large Lean Herbivore
18UWM9	3034	Plant only	Plant products	Insufficient fatty acides	Plant sterol	Present - Indeterminate	None

Analysis of Lipid Residues Extracted from Pottery from 47JE00902 (Finch), Jefferson County, Wisconsin.

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Introduction

Nine pottery sherds were submitted for analysis. Exterior surfaces were ground off to remove contaminants; samples were crushed and absorbed lipid residues were extracted with organic solvents. Lipid extracts were analyzed using gas chromatography (GC), high temperature GC (HT-GC) and high temperature gas chromatography with mass spectrometry (HT-GC/MS). Residue identifications were based on fatty acid decomposition patterns of experimental residues, lipid distribution patterns and the presence of biomarkers. Procedures for the identification of archaeological residues are outlined below; analytical procedures and results are then presented.

The Identification of Archaeological Residues

Identification of Fatty Acids

Fatty acids are the major constituents of fats and oils (lipids) and occur in nature as triglycerides, consisting of three fatty acids attached to a glycerol molecule by ester-linkages. The shorthand convention for designating fatty acids, Cx:yωz, contains three components. The "Cx" refers to a fatty acid with a carbon chain length of x number of atoms. The "y" represents the number of double bonds or points of unsaturation, and the "ωz" indicates the location of the most distal double bond on the carbon chain, i.e. closest to the methyl end. Thus, the fatty acid expressed as C18:1ω9, refers to a mono-unsaturated isomer with a chain length of 18 carbon atoms with a single double bond located nine carbons from the methyl end of the chain. Similarly, the shorthand designation, C16:0, refers to a saturated fatty acid with a chain length of 16 carbons.

Their insolubility in water and relative abundance compared to other classes of lipids, such as sterols and waxes, make fatty acids suitable for residue analysis. Since employed by Condamin et al. (1976), gas chromatography has been used extensively to analyze the fatty acid component of absorbed archaeological residues. The composition of uncooked plants and animals provides important baseline information, but it is not possible to directly compare modern uncooked plants and animals with highly degraded archaeological residues. Unsaturated fatty acids, which are found widely in fish and plants, decompose more readily than saturated fatty acids, sterols or waxes. In the course of decomposition, simple addition reactions might occur at points of unsaturation (Solomons 1980) or peroxidation might lead to the formation of a variety of volatile and non-volatile products which continue to degrade (Frankel 1991). Peroxidation occurs most readily in fatty acids with more than one point of unsaturation.

Attempts have been made to identify archaeological residues using criteria that discriminate uncooked foods (Marchbanks 1989; Skibo 1992; Loy 1994). The major drawback of the distinguishing ratios proposed by Marchbanks (1989), Skibo (1992) and Loy (1994) is they have never been empirically tested. The proposed ratios are based on criteria that discriminate food classes on the basis of their original fatty acid composition. The resistance of these criteria to the effects of decompositional changes has not been demonstrated. Rather, Skibo (1992) found his fatty acid ratio criteria could not be used to identify highly decomposed archaeological samples.

In order to identify a fatty acid ratio unaffected by degradation processes, Patrick et al. (1985) simulated the long-term decomposition of one sample and monitored the resulting changes. An experimental cooking residue of seal was prepared and degraded in order to identify a stable fatty acid ratio. Patrick et al. (1985) found that the ratio of two C18:1 isomers, oleic and vaccenic, did not change with decomposition; this fatty acid ratio was then used to identify an archaeological vessel residue as seal. While the fatty acid composition of uncooked foods must be known, Patrick et al. (1985) showed that the effects of cooking and decomposition over long periods of time on the fatty acids must also be understood.

Development of the Identification Criteria

As the first stage in developing the identification criteria used herein, the fatty acid compositions of more than 130 uncooked Native food plants and animals from Western Canada were determined using gas chromatography (Malainey 1997; Malainey et al. 1999a). When the fatty acid compositions of modern food plants and animals were subject to cluster and principal component analyses, the resultant groupings generally corresponded to divisions that exist in nature (Table 1). Clear differences in the fatty acid composition of large mammal fat, large herbivore meat, fish, plant roots, greens and berries/seeds/nuts were detected, but the fatty acid composition of meat from medium-sized mammals resembles berries/seeds/nuts.

Samples in cluster A, the large mammal and fish cluster had elevated levels of C16:0 and C18:1 (Table 1). Divisions within this cluster stemmed from the very high level of C18:1 isomers in fat, high levels of C18:0 in bison and deer meat and high levels of very long chain unsaturated fatty acids (VLCU) in fish. Differences in the fatty acid composition of plant roots, greens and berries/seeds/nuts reflect the amounts of C18:2 and C18:3ω3 present. The berry, seed, nut and small mammal meat samples appearing in cluster B have very high levels of C18:2, ranging from 35% to 64% (Table 1). Samples in subclusters V, VI and VII have levels of C18:1 isomers from 29% to 51%, as well. Plant roots, plant greens and some berries appear in cluster C. All cluster C samples have moderately high levels of C18:2; except for the berries in subcluster XII, levels of C16:0 are also elevated. Higher levels of C18:3ω3 and/or very long chain saturated fatty acids (VLCS) are also common except in the roots which form subcluster XV.

Secondly, the effects of cooking and degradation over time on fatty acid compositions were examined. Originally, 19 modern residues of plants and animals from the plains, parkland and forests of Western Canada were prepared by cooking samples of meats, fish and plants, alone or combined, in replica vessels over an open fire (Malainey 1997; Malainey et al. 1999b). After four days at room temperature, the vessels were broken and a set of sherds analysed to determine changes after a short term of decomposition. A second set of sherds remained at room temperature for 80 days, then placed in an oven at 75°C for a period of 30 days in order to simulate the processes of long term decomposition. The relative percentages were calculated on the basis of the ten fatty acids (C12:0, C14:0, C15:0, C16:0, C16:1, C17:0, C18:0, C18:1ω9, C18:1ω11, C18:2) that regularly appeared in Precontact Period vessel residues from Western Canada. Observed changes in fatty acid composition of the experimental cooking residues enabled the development of a method for identifying the archaeological residues (Table 2).

It was determined that levels of medium chain fatty acids (C12:0, C14:0 and C15:0), C18:0 and C18:1 isomers in the sample could be used to distinguish degraded experimental cooking residues (Malainey 1997; Malainey et al. 1999b). Higher levels of medium chain fatty acids, combined with low levels of C18:0 and C18:1 isomers, were detected in the decomposed experimental residues of plants, such as roots, greens and most berries. High levels of C18:0 indicated the presence of large herbivores. Moderate levels of C18:1 isomers, with low levels of C18:0, indicated the presence of either fish or foods similar in composition to corn. High levels of C18:1 isomers with low levels of C18:0, were found in residues of beaver or foods of similar fatty acid composition. The criteria for identifying six types of residues were established experimentally; the seventh type, plant with large herbivore, was inferred (Table 2). These criteria were applied to residues extracted from more than 200 pottery cooking vessels from 18 Western Canadian sites (Malainey 1997; Malainey et al. 1999c; 2001b). The identifications were found to be consistent with the evidence from faunal and tool assemblages for each site.

Work has continued to understand the decomposition patterns of various foods and food combinations (Malainey et al. 2000a, 2000b, 2000c, 2001a; Quigg et al. 2001). The collection of modern foods has expanded to include plants from the Southern Plains. The fatty acid compositions of mesquite beans (*Prosopis glandulosa*), Texas ebony seeds (*Pithecellobium ebano Berlandier*), tasajillo berry (*Opuntia leptocaulis*), prickly pear fruit and pads (*Opuntia engelmannii*), Spanish dagger pods (*Yucca treculeana*), cooked sotol (*Dasylirion wheeler*), agave (*Agave lechuguilla*), cholla (*Opuntia imbricata*), piñon (*Pinus edulis*) and Texas mountain laurel (or mescal) seed (*Sophora secundiflora*) have been determined. Experimental residues of many of these plants, alone or in combination with deer meat, have been prepared by boiling foods in clay cylinders or using sandstone for either stone boiling (Quigg et al. 2000) or as a griddle. In order to accelerate the processes of oxidative degradation that naturally occur at a slow rate with the passage of time, the rock or clay tile containing the experimental residue was placed in an oven at 75°C. After either 30 or 68 days, residues were extracted and analysed using gas chromatography. The results of these decomposition studies enabled refinement of the identification criteria (Malainey 2007).

Using Lipid Distribution and Biomarkers to Identify Archaeological Residues

Archaeological scientists working in the United Kingdom have had tremendous success using high temperature-gas chromatography (HT-GC) and gas chromatography with mass spectrometry (HT-GC/MS) to identify biomarkers. High temperature gas chromatography is used to separate and assess a wide range of lipid components, including fatty acids, long chain alcohols and hydrocarbons, sterols, waxes, terpenoids and triacylglycerols (Evershed et al. 1990, Evershed et al. 2001). The molecular structure of separated components is elucidated by mass spectrometry (Evershed 2000).

Triacylglycerols, diacylglycerols and sterols can be used to distinguish animal-derived residues, which contain cholesterol and significant levels of both triacylglycerols, from plant-derived residues, indicated by plant sterols, such as β-sitosterol, stigmasterol and campesterol, and only traces of triacylglycerols (Evershed 1993; Evershed et al. 1997a; Dudd and Evershed 1998). Barnard et al. (2007), however, have recently suggested that microorganisms living off residues can introduce β-sitosterol into residues resulting from the preparation of animal products. Waxes, which are long-chain fatty acids and long-chain alcohols that form protective coatings on skin, fur, feathers, leaves and fruit, also resist decay. Evershed et al. (1991) found epicuticular leaf waxes from plants of the genus *Brassica* in vessel residues from a Late Saxon/Medieval settlement. Cooking experiments later confirmed the utility of nonacosane, nonacosan-15-one and nonacosan-15-ol to indicate the preparation of leafy vegetables, such as turnip or cabbage (Charters et al. 1997). Reber et al. (2004) recently suggested *n*-dotriacontanol could serve as an effective biomarker for maize in vessel residues from sites located in Midwestern and Eastern North America. Beeswax can be identified by the presence and distribution of n-alkanes with carbon chains 23 to 33 atoms in length and palmitic acid wax esters with chains between 40 and 52 carbons in length (Heron et al. 1994; Evershed et al. 1997b).

Terpenoid compounds, or terpenes, are long chain alkenes that occur in the tars and pitches of higher plants. The use of GC and GC/MS to detect the diterpenoid, dehydroabietic acid, from conifer products in archaeological residues extends over a span of 25 years (Shackley 1982; Heron and Pollard 1988). Lupeol, α- and β-amyrin and their derivatives indicate the presence of plant materials (Regert 2007). Eerkens (2002) used the predominance of the diterpenoid, Δ–8(9)-isopimaric acid, in a vessel residue from the western Great Basin to argue it contained piñon resins. Other analytical techniques have also been used to identify terpenoid compounds. Sauter et al. (1987) identified the triterpenoid, betulin in Iron Age tar to confirm the tar was produced from birch. Azelaic acid is a short chain dicarboxylic acid is associated with the oxidation of unsaturated fatty acids (Regert et al. 1998).

Unsaturated fatty acids are most abundant in seed oils; its presence may indicate the residue reflects the processing of plant seeds.

The data obtained by HT-GC and HT-GC/MS analysis is useful for distinguishing plant residues, animal residues and plant/animal combinations. As noted above, the sterol cholesterol is associated with animal products; β-sitosterol, stigmasterol and campesterol are associated with plant products. The presence and abundance of triacylglycerols (TAGs) also varies with the material of origin. When present, amounts of TAGs tend to decrease with increasing numbers of carbon atoms in plant residues (Malainey et al. 2010, 2014, in press). The peak arising from C48 TAGs is largest and peak size (and area) progressively decreases with the C54 TAG peak being the smallest. A line drawn to connect the tops of the C48, C50, C52 and C54 TAG peaks slopes down to the right. This pattern is due to the preponderance of triacylglycerols with fatty acids having carbon chains ranging between 12 and 16 in length; C46 TAG peaks may also be detected. In animal residues, amounts of TAGs tend to increase with carbon numbers, with the C52 or C54 TAG peaks being the largest (Malainey et al. 2010, 2014, in press). A line drawn to connect the tops of the C48, C50, C52 and C54 TAG peaks either resembles a hill or the line slopes up to the right. A parabola-like pattern, such as the shape of a "normal distribution," can also occur in the residues of oil seeds that contain high levels of C18:1 isomers (Malainey et al. 2010, 2014, in press). This pattern is due to the abundance of triacylglycerols composed of fatty acids with mostly chain lengths of 16 or 18 carbons.

Methodology

Descriptions of the samples are presented in Table 4. The exterior surfaces of each sample were ground off with a Dremel® tool fitted with a silicon carbide bit; immediately thereafter, it was crushed with a hammer mortar and pestle and the powder transferred to an Erlenmeyer flask. Lipids were extracted using a variation of the method developed by Folch et al. (1957). The powdered sample was mixed with a 2:1 mixture, by volume, of chloroform and methanol (2 × 25 mL) using ultrasonication (2 × 10 min). Solids were removed by filtering the solvent mixture into a separatory funnel. The lipid/solvent filtrate was washed with 13.3 mL of ultrapure water. Once separation into two phases was complete, the lower chloroform-lipid phase was transferred to a round-bottomed flask and the chloroform removed by rotary evaporation. Any remaining water was removed by evaporation with 2-propanol (1.5 mL); 1.5 mL of chloroform-methanol (2:1, v/v) was used to transfer the dry total lipid extract to a screw-top glass vial with a Teflon®-lined cap. The sample was flushed with nitrogen and stored in a -20°C freezer.

Preparation of FAMES

A 400 µL aliquot of the total lipid extract solution was placed in a screw-top test tube and dried in a heating block under nitrogen. Fatty acid methyl esters (FAMES) were prepared by treating the dry lipid with 3 mL of 0.5 N anhydrous hydrochloric acid in methanol (68°C; 60 min). Fatty acids that occur in the sample as di- or triglycerides are detached from the glycerol molecule and converted to methyl esters. After cooling to room temperature, 2.0 mL of ultrapure water was added; FAMES were recovered with petroleum ether (2 × 1.5 mL) and transferred to a vial. The solvent was removed by heat under a gentle stream of nitrogen; the FAMES were dissolved in 75 µL of *iso*-octane then transferred to a GC vial with a conical glass insert.

Preparation of TMS derivatives

A 150-200 µL aliquot of the total lipid extract solution was placed in a screw-top vial and dried under nitrogen. Trimethylsilyl (TMS) derivatives were prepared by treating the lipid with 70 µL of *N,O*-bis(trimethylsilyl)trifluoroacetamide (BSTFA) containing 1% trimethylchlorosilane, by volume (70ºC; 30 min). The sample was then dried under nitrogen and the TMS derivatives were redissolved in 100 µL of hexane.

Solvents and chemicals were checked for purity by running a sample blank. Traces of fatty acid contamination were subtracted from sample chromatograms. The relative percentage composition was calculated by dividing the integrated peak area of each fatty acid by the total area of fatty acids present in the sample. In order to identify the residue on the basis of fatty acid composition, the relative percentage composition was determined first with respect to all fatty acids present in the sample (including very long chain fatty acids) and second with respect to the ten fatty acids utilized in the development of the identification criteria (C12:0, C14:0, C15:0, C16:0, C16:1, C17:0, C18:0, C18:1ω9, C18:1ω11 and C18:2) (not shown). The second step is necessary for the application of the identification criteria presented in Table 2. It must be understood that the identifications given do not necessarily mean that those particular foods were actually prepared because different foods of similar fatty acid composition and lipid content would produce similar residues (see Table 3). It is possible only to say that the material of origin for the residue was similar in composition to the food(s) indicated. High temperature gas chromatography and high temperature gas chromatography with mass spectrometry is used to further clarify the identifications.

Gas Chromatography Analysis Parameters

The GC analysis was performed on a Varian 3800 gas chromatograph fitted with a flame ionization detector connected to a personal computer. Samples were separated using a VF-23 fused silica capillary column (30 m × 0.25 mm I.D.; Varian; Palo Alto, CA). An autosampler injected the sample using a split/splitless injection system. Hydrogen was used as the carrier gas with a column flow of 1.0 mL/min. Column temperature was increased from 80°C to 140°C at a rate of 20°C per minute then increased to 185°C at a rate of 4°C per minute. After a 4.0 minute hold, the temperature was further increased to 250°C at 10°C per minute and held for 2 minutes. Chromatogram peaks were integrated using Varian MS Workstation® software and identified through comparisons with external qualitative standards (NuCheck Prep; Elysian, MN).

High Temperature Gas Chromatography and Gas Chromatography with Mass Spectrometry

Both HT-GC and HT GC-MS analyses were performed on a Varian 3800 gas chromatograph fitted with a flame ionization detector and a Varian 4000 mass spectrometer connected to a personal computer. For HT-GC analysis, the sample was injected onto a DB-1HT fused silica capillary column (15 m × 0.32 mm I.D.; Agilent J&W; Santa Clara, CA) connected to the flame ionization detector, using hydrogen as the carrier gas. The column temperature was held at 50°C for 1 minute then increased to 350°C at a rate of 15°C per minute and held for 26 minutes. For HT-GC/MS analysis, samples were injected onto a DB-5HT fused silica capillary column (30 m × 0.25 mm I.D.; Agilent J&W; Santa Clara, CA) connected to the ion trap mass spectrometer in an external ionization configuration using helium as the carrier gas. After a 1 minute hold at 50°C, the column temperature was increased to 180°C at a rate of 40°C per minute then ramped up to 230°C at a rate of 5°C per minute and finally increased to 350°C at a rate of 15°C per minute and held for 27.75 minutes. The Varian 4000 mass spectrometer was operated in electron-impact ionization mode scanning from m/z 50-700. Chromatogram peaks and MS spectra were processed using Varian MS Workstation® software and identified through comparisons with external qualitative standards (Sigma Aldrich; St. Louis, MO and NuCheck Prep; Elysian, MN), reference samples and the National Institute of Standards and Technology (NIST) database.

Results of Archaeological Data Analysis

Lipid compositions of the extracted pottery residues are presented in Table 5. Fatty acid compositions of the residues were determined by using the area under the chromatographic peak of a given fatty acid, as calculated by the Varian MS Workstation® software minus the solvent blank.

The term "Area" represents the area under the chromatographic peak of a given fatty acid, as calculated by the Varian MS Workstation® software minus the solvent blank. Hydroxide or peroxide degradation products can interfere with the integration of the C22:0 and C22:1 peaks; these fatty acids were excluded from the analysis. Residue 18UWM 9 was almost completely devoid of fatty acids.

High C18:0 level "Large Herbivore" with Other Foods

The fatty acid compositions of five residues, 18UWM 1, 18UWM 3, 18UWM 4, 18UWM 5, and 18UWM 8 are characterized by high levels of C18:0, ranging between 28.73% and 61.37%. High levels of C18:0 result from the preparation of large herbivores, such as bison, deer, moose, fat elk meat or other bovines or cervids; but javelina meat and tropical oil seeds also produce residues high in C18:0 and must be considered as potential sources where available. While all five residues reflect the presence of large herbivore meat, their relative fatty acid compositions are quite variable and suggest the meat was prepared in combination with different foods or other foods were prepared in pots also used to cook large herbivore meat.

Large Herbivore with Plant Roots: Residues extracted from three vessels, 18UWM 1, 18UWM 4 and 18UWM 8 appear to represent a combination of large herbivore meat and plant roots. Although the levels of medium chain saturated fatty acids (sum of C12:0, C14:0 and C15:0) do not exceed 10% in any of the residues, the presence of plant roots is suggested by elevated levels of the fatty acid C17:0. The level of C17:0 is 5.80% in 18UWM 1, 5.73% in 18UWM 4 and 4.80% in 18UWM 8. The level of C18:1 isomers in all three residues is very low, less than 5%, which indicates the meat was quite lean. The very high level of C18:0 in residue 18UWM 1, 61.37%, indicates the animal was probably taken in mid-late winter (January or February) when it was fat-depleted. The plant sterol β-sitosterol may occur all three residues; the animal sterol cholesterol may occur in residues 18UWM 4 and 18UWM 8.

Triacylglycerols were detected in residue 18UWM 8. A large C48 TAG peak occurred followed by progressively smaller C50 and C52 TAG peaks, which suggests the presence of plant material.

Large Herbivore and Medium Fat Content Foods: Residue 18UWM 3 has a high level of the fatty acid C18:0 and a medium level of C18:1 isomers, 21.50%, suggesting it is a combination of large herbivore meat and medium fat content foods. As indicated in Table 3, both plant and animal foods can produce medium fat content residues. Examples of medium fat content plant foods include corn, mesquite and cholla. Freshwater fish, terrapin, Rabdotus snail and late winter, fat-depleted elk are examples of medium fat content animal foods. Both the animal sterol cholesterol and the plant sterol β-sitosterol probably occur in this residue; the plant sterol stigmasterol may occur. Dehydroabietic acid likely occurs in residue 18UWM 3. This biomarker indicates the presence of conifer products, which may have been introduced from firewood, resins or other conifer products.

Very long chain polyunsaturated fatty acids, C20:3 and C20:5, were detected in the residue and their occurrence indicates modern contamination. These polyunsaturated fatty acids can not survive long periods of time and must have been introduced relatively recently. They were excluded from relative fatty acid compositions presented in Table 4. The presence of these polyunsaturated fatty acids did not affect the residue identification.

Large Herbivore and Low Fat Content Plants: Residue 18UWM 5 is characterized by high levels of C18:0, indicating the presence of large herbivore products, and levels of medium chain saturated fatty acids exceeding 10%, indicating the presence of low fat content plant products. Many types of plant greens, plant roots, starchy seeds and several types of berries produce residues with elevated levels of medium chain fatty acids. The animal sterol cholesterol and the conifer biomarker dehydroabietic acid probably occur in this residue; the plant sterols β-sitosterol and stigmasterol may occur.

Moderately high levels of the very long chain polyunsaturated fatty acids, C20:3 and C20:5, were detected in the residue and their occurrence indicates modern contamination. These polyunsaturated fatty acids can not survive long periods of time and must have been introduced relatively recently. They were excluded from relative fatty acid compositions presented in Table 4. The presence of these polyunsaturated fatty acids probably did not greatly affect the residue identification.

Complex Composition: Large Herbivore Products and Plants

Residue 18UWM 7 is a complex composition of large herbivore and plant products. The level of the fatty acid C18:0 is 25.46%, the level of C18:1 isomers is 14.06% and the level of medium chain saturated fatty acids is 15.30%. As shown in Table 2, this fatty acid composition is very similar to that of "Large herbivore with Plant OR Bone Marrow" but the high level of medium chain saturated fatty acids indicates low fat content plant greens, roots, starchy seeds or berries are present. The residue appears to either represent a combination of large herbivore bone marrow and low fat content plants OR a combination of large herbivore meat, medium fat content foods (such as maize) and low fat content plants. The plant sterol β-sitosterol definitely occurs in the residue. The animal sterol cholesterol and the conifer biomarker dehydroabietic acid may occur.

Decomposed Nut Oil and Other Foods

Residue 18UWM 6 appears to represent a combination of decomposed nut oil and other foods. The fatty acid C16:0 appears in all foods and archaeological food residues. The mean and standard deviation of C16:0 levels in 600 archaeological residues previously identified as food was determined and found to be $31 \pm 9\%$. The level of the fatty acid 16:0 in the residue 18UWM 6 is 54.91%, which is well outside of the expected range of 22% and 40%. The elevated levels of C16:0 in this residue is likely due to presence of decomposed nut oil but various other foods, such as animal products and low fat content plants were also prepared in this vessel.

The very high level of C16:0 in the residue distorts the relative fatty acid composition but other types of foods occur. The level of the fatty acid C18:0 is elevated in this residue, 21.16%, which suggests the presence of animal products, possibly even large herbivore flesh. The level of medium chain saturated fatty acids (the sum of C12:0, C14:0 and C15:0) in residue 18UWM 6 is over 9%. As noted above, elevated levels of medium chain saturated fatty acids in North American archaeological lipid residues indicate the preparation of low fat content plants, such as roots, greens, starchy seeds and certain berries. The residue is likely a combination of decomposed nut oil, animal products and low fat content plants. The animal sterol cholesterol, the plant sterol β-sitosterol and the conifer biomarker dehydroabietic acid may all occur in this residue.

Low levels of very long chain polyunsaturated fatty acids, C20:3 and C20:5, were detected in the residue and their occurrence indicates modern contamination. These polyunsaturated fatty acids can not survive long periods of time and must have been introduced relatively recently. They were excluded from relative fatty acid compositions presented in Table 4. The presence of these polyunsaturated fatty acids did not affect the residue identification.

<u>Medium Fat Content</u>

The level of C18:1 isomers in residue 18UWM 2 is 15.38%, which indicates the presence of medium fat content foods. As noted above, both plant and animal foods can produce medium fat content residues. Examples of medium fat content plant foods include corn, mesquite and cholla. Freshwater fish, terrapin, Rabdotus snail and late winter, fat-depleted elk are examples of medium fat content animal foods. It is quite likely that both animal and plant products occur in residue 18UWM 2. Plant products are indicated by the confirmed presence of the plant sterol β-sitosterol as well as the possible presence of both the plant sterol stigmasterol and the conifer biomarker dehydroabietic acid. The presence of animal products is indicated by the elevated level of the fatty acid C18:0, 23.49%, and the likely presence of the animal sterol cholesterol.

Very long chain polyunsaturated fatty acids, C20:3 and C20:5, were detected in the residue and their occurrence indicates modern contamination. These polyunsaturated fatty acids can not survive long periods of time and must have been introduced relatively recently. They were excluded from relative fatty acid compositions presented in Table 4. The presence of these polyunsaturated fatty acids did not affect the residue identification.

Insufficient Fatty Acids – Plant Products may occur

Insufficient fatty acids were present in residue 18UWM 9 to attempt identification but the plant sterol β-sitosterol may be present. It is possible this vessel may have been used to store plant products.

REFERENCES CITED

Barnard, H., A. N. Dooley and K. F. Faull
2007 Chapter 5: An Introduction to Archaeological Lipid Analysis by GC/MS. In *Theory and Practice of Archaeological Residue Analysis*, edited by H. Barnard and J. W. Eerkens, pp.42-60. British Archaeological Reports International Series 1650. Oxford, UK.

Charters, S., R. P. Evershed, A. Quye, P. W. Blinkhorn and V. Denham
1997 Simulation Experiments for Determining the Use of Ancient Pottery Vessels: Te Behaviour of Epicuticular Leaf Wax during Boiling of a Leafy Vegetable. *Journal of Archaeological Science* 24: 1-7.

Condamin, J., F. Formenti, M. O. Metais, M. Michel, and P. Blond
1976 The Application of Gas Chromatography to the Tracing of Oil in Ancient Amphorae. *Archaeometry* 18(2):195-201.

Dudd, S. N. and R. P. Evershed
1998 Direct demonstration of milk as an element of archaeological economies. *Science* 282: 1478-1481.

Eerkens, J. W.
2002 The Preservation and Identification of Pinon Resins by GC-MS in Pottery from the Western Great Basin. *Archaeometry* 44(1):95-105.

Evershed, R.P.
1993 Biomolecular Archaeology and Lipids. *World Archaeology* 25(1):74-93.

Evershed, R. P.
2000 Biomolecular Analysis by Organic Mass Spectrometry. In *Modern Analytical Methods in Art and Archaeology*, edited by E. Ciliberto and G. Spoto, pp. 177-239. Volume 155, Chemical Analysis. John Wiley & Sons, New York.

Evershed, R. P., C. Heron and L. J. Goad
1990 Analysis of Organic Residues of Archaeological Origin by High Temperature Gas Chromatography and Gas Chromatography-Mass Spectroscopy. *Analyst* 115:1339-1342.

Evershed, R.P., C. Heron and L.J. Goad
1991 Epicuticular Wax Components Preserved in Potsherds as Chemical Indicators of Leafy Vegetables in Ancient Diets. *Antiquity* 65:540-544.

Evershed, R. P., H. R. Mottram, S. N. Dudd, S. Charters, A. W. Stott, G. J. Lawrence, A. M. Gibson, A. Conner, P. W. Blinkhorn and V. Reeves
1997a New Criteria for the Identification of Animal Fats in Archaeological Pottery. *Naturwissenschaften* 84: 402-406.

Evershed, R. P., S. J. Vaugh, S. N. Dudd and J. S. Soles
1997b Fuel for Thought? Beeswax in Lamps and Conical Cups from Late Minoan Crete. *Antiquity* 71: 979-985.

Evershed, R. P., S. N. Dudd, M. J. Lockheart and S. Jim
2001 Lipids in Archaeology. In *Handbook of Archaeological Sciences*, edited by D. R. Brothwell and A. M. Pollard, pp. 331-349. John Wiley & Sons, New York.

Folch, J., M. Lees and G. H. Sloane-Stanley
1957 A simple method for the isolation and purification of lipid extracts from brain tissue. *Journal of Biological Chemistry* 191:833.

Frankel, E. N.
1991 Recent Advances in Lipid Oxidation. *Journal of the Science of Food and Agriculture* 54:465-511.

Heron, C., and A.M. Pollard
1988 The Analysis of Natural Resinous Materials from Roman Amphoras. In *Science and Archaeology Glasgow 1987. Proceedings of a Conference on the Application of Scientific Techniques to Archaeology, Glasgow, 1987*, edited by E. A. Slater and J. O. Tate, pp. 429-447. BAR British Series 196 (ii), Oxford.

Heron, C., N. Nemcek, K. M. Bonfield, J. Dixon and B. S. Ottaway
1994 The Chemistry of Neolithic Beeswax. *Naturwissenschaften* 81: 266-269.

Loy, T.
1994 Residue Analysis of Artifacts and Burned Rock from the Mustang Branch and Barton Sites (41HY209 and 41HY202). In: *Archaic and Late Prehistoric Human Ecology in the Middle Onion Creek Valley, Hays County, Texas. Volume 2: Topical Studies,* by R. A. Ricklis and M. B. Collins, pp. 607- 627. Studies in Archeology 19, Texas Archaeological Research Laboratory, The University of Texas at Austin.

Malainey, M. E.
1997 The Reconstruction and Testing of Subsistence and Settlement Strategies for the Plains, Parkland and Southern boreal forest. Unpublished Ph.D. thesis, University of Manitoba.

Malainey, M. E.
2007 Chapter 7: Fatty Acid Analysis of Archaeological Residues: Procedures and Possibilities. In *Theory and Practice of Archaeological Residue Analysis*, edited by H. Barnard and J. W. Eerkens, pp.77-89. British Archaeological Reports International Series 1650. Oxford, UK.

Malainey, M. E., M. Álvarez, I. Briz i Godino, D. Zurro, E. Verdún i Castelló and T. Figol
2014 The Use of Shells as Tools by Hunter-Gatherers in the Beagle Channel (Tierra del Fuego, South America): An Ethnoarchaeological Experiment. *Archaeological and Anthropological Sciences* 7 (2): 187-200.

Malainey, M. E., P. J. Innes and T. J. Figol
2010 Taking a Second Look: Results of the Re-analysis of Archaeological Lipid Residues from North America and Beyond, Paper presented at the *75nd Annual Meeting of the Society for American Archaeology*, St. Louis, MO.

Malainey, M. E., P. Innes and T. Figol
in press Taking a Second Look: A Functional Analysis of Burned Rock Features from Eight Sites in Texas and Arizona. Chapter prepared for a volume edited by H. Hoekman-Sites and M. Raviele to be published by the University of Colorado Press (40 pages).

Malainey, M. E., K. L. Malisza, R. Przybylski and G. Monks
2001a The Key to Identifying Archaeological Fatty Acid Residues. Paper presented at the *34th Annual Meeting of the Canadian Archaeological Association*, Banff, Alberta, May 2001.

Malainey, M. E., R. Przybylski and B. L. Sherriff
1999a The Fatty Acid Composition of Native Food Plants and Animals of Western Canada. *Journal of Archaeological Science* 26:83-94.

1999b The Effects of Thermal and Oxidative Decomposition on the Fatty Acid Composition of Food Plants and Animals of Western Canada: Implications for the Identification of archaeological vessel residues. *Journal of Archaeological Science* 26:95-103.

1999c Identifying the former contents of Late Precontact Period pottery vessels from Western Canada using gas chromatography. *Journal of Archaeological Science* 26(4): 425-438.

2001b One Person's Food: How and Why Fish Avoidance May Affect the Settlement and Subsistence Patterns of Hunter-Gatherers. *American Antiquity* 66(1): 141-161.

Malainey, M. E., R. Przybylski and G. Monks
2000a The identification of archaeological residues using gas chromatography and applications to archaeological problems in Canada, United States and Africa. Paper presented at *The 11th Annual Workshops in Archaeometry*, State University of New York at Buffalo, February 2000.

2000b Refining and testing the criteria for identifying archaeological lipid residues using gas chromatography. Paper presented at the *33rd Annual Meeting of the Canadian Archaeological Association*, Ottawa, May 2000.

2000c Developing a General Method for Identifying Archaeological Lipid Residues on the Basis of Fatty Acid Composition. Paper presented at the *Joint Midwest Archaeological & Plains Anthropological Conference*, Minneapolis, Minnesota, November 2000.

Marchbanks, M. L.
1989 Lipid Analysis in Archaeology: An Initial Study of Ceramics and Subsistence at the George C. Davis Site. Unpublished M.A. thesis, The University of Texas at Austin.

Patrick, M., A. J. de Konig and A. B. Smith
1985 Gas Liquid Chromatographic Analysis of Fatty Acids in Food Residues from Ceramics Found in the Southwestern Cape, South Africa. *Archaeometry* 27(2): 231-236.

Quigg, J. M., C. Lintz, S. Smith and S. Wilcox
2000 *The Lino Site: A Stratified Late Archaic Campsite in a Terrace of the San Idelfonzo Creek, Webb County, Southern Texas*. Technical Report No. 23765, TRC Mariah Associates Inc., Austin. Texas Department of Transportation, Environmental Affairs Division, Archaeological Studies Program Report 20, Austin.

Quigg, J. M., M. E. Malainey, R. Przybylski and G. Monks
2001 No bones about it: using lipid analysis of burned rock and groundstone residues to examine Late Archaic subsistence practices in South Texas. *Plains Anthropologist* 46(177): 283-303.

Reber, E. A., S. N. Dudd, N. J. van der Merwe and R. P. Evershed
2004 Direct detection of maize in pottery residue via compound specific stable carbon isotope analysis. *Antiquity* 78: 682-691.

Regert, M., H. A. Bland, S. N. Dudd, P. F. van Bergen and R. P. Evershed
1998 Free and Bound Fatty Acid Oxidation Products in Archaeological Ceramic Vessels. *Philosophical Transactions of the Royal Society of London, B* 265 (1409):2027-2032.

Regert, M.
2007 Chapter 6: Elucidating Pottery Function using a Multi-step Analytical Methodology combining Infrared Spectroscopy, Chromatographic Procedures and Mass Spectrometry. In *Theory and Practice of Archaeological Residue Analysis*, edited by H. Barnard and J. W. Eerkens, pp.61-76. British Archaeological Reports International Series 1650. Oxford, UK.

Sauter, F., E.W.H. Hayek, W. Moche and U. Jordis
1987 Betulin aus archäologischem Schwelteer. *Z. für Naturforsch* 42c (11-12):1151-1152.

Shackley, M.
1982 Gas Chromatographic Identification of a Resinous Deposit from a 6th Century Storage Jar and Its Possible Identification. *Journal of Archaeological Science* 9:305-306.

Skibo, J. M.
1992 *Pottery Function: A Use-Alteration Perspective*. Plenum Press, New York.

Solomons, T. W. G.
1980 *Organic Chemistry*. John Wiley & Sons, Toronto.

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Table 1. Summary of average fatty acid compositions of modern food groups generated by hierarchical cluster analysis.

Cluster	**A**				**B**						**C**				
Subcluster	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**XIII**	**XIV**	**XV**
Type	Mammal Fat and Marrow	Large Herbivore Meat	Fish	Fish	Berries and Nuts	Mixed	Seeds and Berries	Roots	Seeds	Mixed	Greens	Berries	Roots	Greens	Roots
C16:0	19.90	19.39	16.07	14.10	3.75	12.06	7.48	19.98	7.52	10.33	18.71	3.47	22.68	24.19	18.71
C18:0	7.06	20.35	3.87	2.78	1.47	2.36	2.58	2.59	3.55	2.43	2.48	1.34	3.15	3.66	5.94
C18:1	56.77	35.79	18.28	31.96	51.14	35.29	29.12	6.55	10.02	15.62	5.03	14.95	12.12	4.05	3.34
C18:2	7.01	8.93	2.91	4.04	41.44	35.83	54.69	48.74	64.14	39.24	18.82	29.08	26.24	16.15	15.61
C18:3	0.68	2.61	4.39	3.83	1.05	3.66	1.51	7.24	5.49	19.77	35.08	39.75	9.64	17.88	3.42
VLCS	0.16	0.32	0.23	0.15	0.76	4.46	2.98	8.50	5.19	3.73	6.77	9.10	15.32	18.68	43.36
VLCU	0.77	4.29	39.92	24.11	0.25	2.70	1.00	2.23	0.99	2.65	1.13	0.95	2.06	0.72	1.10

VLCS- Very Long Chain (C20, C22 and C24) Saturated Fatty Acids
VLCU - Very Long Chain (C20, C22 and C24) Unsaturated Fatty Acids

Table 2. Criteria for the identification of archaeological residues based on the decomposition patterns of experimental cooking residues prepared in pottery vessels.

Identification	**Medium Chain**	**C18:0**	**C18:1 isomers**
Large herbivore	≤ 15%	≥ 27.5%	≤ 15%
Large herbivore with plant OR Bone marrow	low	≥ 25%	15% ≤ X ≤ 25%
Plant with large herbivore	≥ 15%	≥ 25%	no data
Beaver	low	Low	≥ 25%
Fish or Corn	low	≤ 25%	15% ≤ X ≤ 27.5%
Fish or Corn with Plant	≥ 15%	≤ 25%	15% ≤ X ≤ 27.5%
Plant (except corn)	≥ 10%	≤ 27.5%	≤ 15%

Table 3. Known food sources for different types of decomposed residues.

Decomposed Residue Identification	**Plant Foods Known to Produce Similar Residues**	**Animal Foods Known To Produce Similar Residues**
Large herbivore	Tropical seed oils, including sotol seeds	Bison, deer, moose, fall-early winter fatty elk meat, Javelina meat
Large herbivore with plant OR Bone marrow		
Low Fat Content Plant (Plant greens, roots, berries)	Jicama tuber, buffalo gourd, yopan leaves, biscuit root, millet	Cooked Camel's milk
Medium-Low Fat Content Plant	Prickly pear, Spanish dagger	None
Medium Fat Content (Fish or Corn)	Corn, mesquite beans, cholla	Freshwater fish, *Rabdotus* snail, terrapin, late winter fat-depleted elk
Moderate-High Fat Content (Beaver)	Texas ebony	Beaver and probably raccoon or any other fat medium-sized mammals
High Fat Content	High fat nuts and seeds, including acorn and pecan	Rendered animal fat (other than large herbivore), including bear fat
Very High Fat Content	Very high fat nuts and seeds, including pine nuts	Freshly rendered animal fat (other than large herbivore)

Table 4. List of Pottery Samples.

Lab No.	Sample No.	Lot Number	No.	Vessel	Description	Ware	Component	Pieces used	Sample Mass (g)
18UWM 1	UWM-01	09.089-0436	3	3018	Decorated Body Sherd	Dane Incised	Early Woodland	1	11.650
18UWM 2	UWM-02	09.089-3047	1	3007	Decorated Body Sherd	Dane Incised	Early Woodland	1	13.006
18UWM 3	UWM-03	09.089-2776	7	3015	Decorated Body Sherd	Dane Incised	Early Woodland	2	10.092
18UWM 4	UWM-04	09.089-1562	5	2014	Decorated Rim/Body	Shorewood Cord Roughened	Middle Woodland	2	9.094
18UWM 5	UWM-05	09.089-2425	10	2003	Decorated Body Sherd	Shorewood Cord Roughened	Middle Woodland	1	12.452
18UWM 6	UWM-06	09.089-2720	1	2017	Decorated Rim/Body	Shorewood Cord Roughened	Middle Woodland	1	7.999
18UWM 7	UWM-07	09.089-2559	4	2004	Decorated Body Sherd	Naples Stamped	Middle Woodland	1	9.358
18UWM 8	UWM-08	09.089-882	1	2001	Decorated Body Sherd	Havana Zoned	Middle Woodland	1	11.160
18UWM 9	UWM-09	09.089-3107	3	3034	Decorated Body Sherd	Hopewell related	Middle Woodland	1	14.749

Table 5. Lipid compositions of the pottery residues.

Fatty acid	18UWM 1 (dil)		18UWM 2		18UWM 3	
	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	29150	0.33	33917	2.10	24582	1.27
C14:0	107813	1.23	23495	1.45	24327	1.26
C14:1	13333	0.15	0	0.00	0	0.00
C15:0	5934	0.07	21449	1.33	22081	1.14
C16:0	2270203	25.88	594071	36.71	531824	27.54
C16:1	21798	0.25	94085	5.81	15699	0.81
C17:0	509097	5.80	49486	3.06	47494	2.46
C17:1	75746	0.86	108214	6.69	0	0.00
C18:0	5382682	61.37	380232	23.49	698817	36.19
C18:1s	204356	2.33	248919	15.38	415129	21.50
C18:2	13905	0.16	10268	0.63	79788	4.13
C18:3s	1824	0.02	0	0.00	0	0.00
C20:0	92044	1.05	50652	3.13	57296	2.97
C20:1	12239	0.14	0	0.00	12666	0.66
C24:0	8940	0.10	3685	0.23	1509	0.08
C24:1	22312	0.25	0	0.00	0	0.00
Total	8771375	100.00	1618473	100.00	1931212	100.00
Biomarkers	Possibly β-sitosterol		β-sitosterol; probably Cholesterol;; possibly Stigmasterol; possibly Dehydroabietic acid		Probably Cholesterol; probably β-sitosterol; possibly Stigmasterol; probably Dehydroabietic acid	
Triacyl-glycerols	None detected		None detected		None detected	
Identification	Fat-depleted large herbivore with plant root		Medium fat content, plant and animal products present		Large herbivore and medium fat content foods	
Comments			Elevated levels of polyunsaturated fatty acids indicative of modern contamination were detected in the residue		Elevated levels of polyunsaturated fatty acids indicative of modern contamination were detected in the residue	

Table 5 continued. Lipid compositions of the pottery residues.

Fatty acid	18UWM 4		18UWM 5		18UWM 6	
	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	73855	1.65	40495	6.48	44213	4.05
C14:0	136114	3.04	31133	4.98	38924	3.57
C14:1	0	0.00	0	0.00	0	0.00
C15:0	139577	3.12	12041	1.93	15959	1.46
C16:0	1480470	33.11	242474	38.82	599042	54.91
C16:1	10775	0.24	0	0.00	0	0.00
C17:0	255950	5.73	15434	2.47	22414	2.05
C17:1	0	0.00	0	0.00	0	0.00
C18:0	2026318	45.32	179480	28.73	230854	21.16
C18:1s	207360	4.64	60743	9.72	102356	9.38
C18:2	23731	0.53	3280	0.53	14610	1.34
C18:3s	0	0.00	0	0.00	0	0.00
C20:0	86639	1.94	32767	5.25	14477	1.33
C20:1	25225	0.56	6799	1.09	8156	0.75
C24:0	4707	0.11	0	0.00	0	0.00
C24:1	0	0.00	0	0.00	0	0.00
Total	4470721	100.00	624646	100.00	1091005	100.00
Biomarkers	Possibly Cholesterol; possibly β-sitosterol;		Probably Cholesterol, possibly β-sitosterol; possibly Stigmasterol; probably Dehydroabietic acid		Possibly Cholesterol, possibly β-sitosterol; possibly Dehydroabietic acid	
Triacyl-glycerols	None detected		None detected		None detected	
Identification	Large herbivore with plant root		Large herbivore and low fat content plants		Decomposed nut oil, animal products and low fat content plants	
Comments	Low levels of polyunsaturated fatty acids indicative of modern contamination were detected in the residue		Moderately high levels of polyunsaturated fatty acids indicative of modern contamination were detected in the residue		Low levels of polyunsaturated fatty acids indicative of modern contamination were detected in the residue	

Table 5 continued. Lipid compositions of the pottery residues.

Fatty acid	18UWM 7		18UWM 8 (dil)		18UWM 9	
	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	26381	6.31	51098	1.05	Insufficient Fatty Acids to Permit Identification	
C14:0	26660	6.38	136180	2.79		
C14:1	0	0.00	0	0.00		
C15:0	10921	2.61	135976	2.79		
C16:0	163472	39.10	1906846	39.06		
C16:1	0	0.00	0	0.00		
C17:0	11955	2.86	234524	4.80		
C17:1	0	0.00	0	0.00		
C18:0	106448	25.46	2184867	44.76		
C18:1s	58799	14.06	146652	3.00		
C18:2	7390	1.77	20929	0.43		
C18:3s	0	0.00	0	0.00		
C20:0	6075	1.45	38353	0.79		
C20:1	0	0.00	14409	0.30		
C24:0	0	0.00	9464	0.19		
C24:1	0	0.00	2171	0.04		
Total	418101	100.00	4881468	100.00		
Biomarkers	β-sitosterol; possibly Cholesterol; probably Dehydroabietic acid		Possibly β-sitosterol; possibly Cholesterol		Possibly β-sitosterol	
Triacyl-glycerols	None detected		Large C48 TAGs and progressively smaller C50 and C52 TAGs		None detected	
Identification	Large herbivore bone marrow and low fat content plants OR Large herbivore meat, medium fat content foods (such as maize) and low fat content plants		Large herbivore with plant roots		Traces of plant material	
Comments						

Analysis of Lipid Residues Extracted from Early and Middle Woodland Pottery from Southeast Wisconsin.

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Introduction

Four pottery sherds were submitted for analysis. Exterior surfaces were ground off to remove any contaminants; samples were crushed and absorbed lipid residues were extracted with organic solvents. Lipid extracts were analyzed using gas chromatography (GC), high temperature GC (HT-GC) and high temperature gas chromatography with mass spectrometry (HT-GC/MS). Residue identifications were based on fatty acid decomposition patterns of experimental residues, lipid distribution patterns and the presence of biomarkers. Procedures for the identification of archaeological residues are outlined below; analytical procedures and results are then presented.

The Identification of Archaeological Residues

Identification of Fatty Acids

Fatty acids are the major constituents of fats and oils (lipids) and occur in nature as triglycerides, consisting of three fatty acids attached to a glycerol molecule by ester-linkages. The shorthand convention for designating fatty acids, Cx:yωz, contains three components. The "Cx" refers to a fatty acid with a carbon chain length of x number of atoms. The "y" represents the number of double bonds or points of unsaturation, and the "ωz" indicates the location of the most distal double bond on the carbon chain, i.e. closest to the methyl end. Thus, the fatty acid expressed as C18:1ω9, refers to a mono-unsaturated isomer with a chain length of 18 carbon atoms with a single double bond located nine carbons from the methyl end of the chain. Similarly, the shorthand designation, C16:0, refers to a saturated fatty acid with a chain length of 16 carbons.

Their insolubility in water and relative abundance compared to other classes of lipids, such as sterols and waxes, make fatty acids suitable for residue analysis. Since employed by Condamin et al. (1976), gas chromatography has been used extensively to analyze the fatty acid component of absorbed archaeological residues. The composition of uncooked plants and animals provides important baseline information, but it is not possible to directly compare modern uncooked plants and animals with highly degraded archaeological residues. Unsaturated fatty acids, which are found widely in fish and plants, decompose more readily than saturated fatty acids, sterols or waxes. In the course of decomposition, simple addition reactions might occur at points of unsaturation (Solomons 1980) or peroxidation might lead to the formation of a variety of volatile and non-volatile products which continue to degrade (Frankel 1991). Peroxidation occurs most readily in fatty acids with more than one point of unsaturation.

Attempts have been made to identify archaeological residues using criteria that discriminate uncooked foods (Marchbanks 1989; Skibo 1992; Loy 1994). The major drawback of the distinguishing ratios proposed by Marchbanks (1989), Skibo (1992) and Loy (1994) is they have never been empirically tested. The proposed ratios are based on criteria that discriminate food classes on the basis of their original fatty acid composition. The resistance of these criteria to the effects of decompositional changes has not been demonstrated. Rather, Skibo (1992) found his fatty acid ratio criteria could not be used to identify highly decomposed archaeological samples.

In order to identify a fatty acid ratio unaffected by degradation processes, Patrick et al. (1985) simulated the long-term decomposition of one sample and monitored the resulting changes. An experimental cooking residue of seal was prepared and degraded in order to identify a stable fatty acid ratio. Patrick et al. (1985) found that the ratio of two C18:1 isomers, oleic and vaccenic, did not change with decomposition; this fatty acid ratio was then used to identify an archaeological vessel residue as seal. While the fatty acid composition of uncooked foods must be known, Patrick et al. (1985) showed that the effects of cooking and decomposition over long periods of time on the fatty acids must also be understood.

<u>Development of the Identification Criteria</u>

As the first stage in developing the identification criteria used herein, the fatty acid compositions of more than 130 uncooked Native food plants and animals from Western Canada were determined using gas chromatography (Malainey 1997; Malainey et al. 1999a). When the fatty acid compositions of modern food plants and animals were subject to cluster and principal component analyses, the resultant groupings generally corresponded to divisions that exist in nature (Table 1). Clear differences in the fatty acid composition of large mammal fat, large herbivore meat, fish, plant roots, greens and berries/seeds/nuts were detected, but the fatty acid composition of meat from medium-sized mammals resembles berries/seeds/nuts.

Samples in cluster A, the large mammal and fish cluster had elevated levels of C16:0 and C18:1 (Table 1). Divisions within this cluster stemmed from the very high level of C18:1 isomers in fat, high levels of C18:0 in bison and deer meat and high levels of very long chain unsaturated fatty acids (VLCU) in fish. Differences in the fatty acid composition of plant roots, greens and berries/seeds/nuts reflect the amounts of C18:2 and C18:3ω3 present. The berry, seed, nut and small mammal meat samples appearing in cluster B have very high levels of C18:2, ranging from 35% to 64% (Table 1). Samples in subclusters V, VI and VII have levels of C18:1 isomers from 29% to 51%, as well. Plant roots, plant greens and some berries appear in cluster C. All cluster C samples have moderately high levels of C18:2; except for the berries in subcluster XII, levels of C16:0 are also elevated. Higher levels of C18:3ω3 and/or very long chain saturated fatty acids (VLCS) are also common except in the roots which form subcluster XV.

Secondly, the effects of cooking and degradation over time on fatty acid compositions were examined. Originally, 19 modern residues of plants and animals from the plains, parkland and forests of Western Canada were prepared by cooking samples of meats, fish and plants, alone or combined, in replica vessels over an open fire (Malainey 1997; Malainey et al. 1999b). After four days at room temperature, the vessels were broken and a set of sherds analysed to determine changes after a short term of decomposition. A second set of sherds remained at room temperature for 80 days, then placed in an oven at 75°C for a period of 30 days in order to simulate the processes of long term decomposition. The relative percentages were calculated on the basis of the ten fatty acids (C12:0, C14:0, C15:0, C16:0, C16:1, C17:0, C18:0, C18:1ω9, C18:1ω11, C18:2) that regularly appeared in Precontact Period vessel residues from Western Canada. Observed changes in fatty acid composition of the experimental cooking residues enabled the development of a method for identifying the archaeological residues (Table 2).

It was determined that levels of medium chain fatty acids (C12:0, C14:0 and C15:0), C18:0 and C18:1 isomers in the sample could be used to distinguish degraded experimental cooking residues (Malainey 1997; Malainey et al. 1999b). Higher levels of medium chain fatty acids, combined with low levels of C18:0 and C18:1 isomers, were detected in the decomposed experimental residues of plants, such as roots, greens and most berries. High levels of C18:0 indicated the presence of large herbivores. Moderate levels of C18:1 isomers, with low levels of C18:0, indicated the presence of either fish or foods similar in composition to corn. High levels of C18:1 isomers with low levels of C18:0, were found in residues of beaver or foods of similar fatty acid composition. The criteria for identifying six types of residues were established experimentally; the seventh type, plant with large herbivore, was inferred (Table 2). These criteria were applied to residues extracted from more than 200 pottery cooking vessels from 18 Western Canadian sites (Malainey 1997; Malainey et al. 1999c; 2001b). The identifications were found to be consistent with the evidence from faunal and tool assemblages for each site.

Work has continued to understand the decomposition patterns of various foods and food combinations (Malainey et al. 2000a, 2000b, 2000c, 2001a; Quigg et al. 2001). The collection of modern foods has expanded to include plants from the Southern Plains. The fatty acid compositions of mesquite beans (*Prosopis glandulosa*), Texas ebony seeds (*Pithecellobium ebano Berlandier*), tasajillo berry (*Opuntia leptocaulis*), prickly pear fruit and pads (*Opuntia engelmannii*), Spanish dagger pods (*Yucca treculeana*), cooked sotol (*Dasylirion wheeler*), agave (*Agave lechuguilla*), cholla (*Opuntia imbricata*), piñon (*Pinus edulis*) and Texas mountain laurel (or mescal) seed (*Sophora secundiflora*) have been determined. Experimental residues of many of these plants, alone or in combination with deer meat, have been prepared by boiling foods in clay cylinders or using sandstone for either stone boiling (Quigg et al. 2000) or as a griddle. In order to accelerate the processes of oxidative degradation that naturally occur at a slow rate with the passage of time, the rock or clay tile containing the experimental residue was placed in an oven at 75°C. After either 30 or 68 days, residues were extracted and analysed using gas chromatography. The results of these decomposition studies enabled refinement of the identification criteria (Malainey 2007).

Using Lipid Distribution and Biomarkers to Identify Archaeological Residues

Archaeological scientists working in the United Kingdom have had tremendous success using high temperature-gas chromatography (HT-GC) and gas chromatography with mass spectrometry (HT-GC/MS) to identify biomarkers. High temperature gas chromatography is used to separate and assess a wide range of lipid components, including fatty acids, long chain alcohols and hydrocarbons, sterols, waxes, terpenoids and triacylglycerols (Evershed et al. 1990, Evershed et al. 2001). The molecular structure of separated components is elucidated by mass spectrometry (Evershed 2000).

Triacylglycerols, diacylglycerols and sterols can be used to distinguish animal-derived residues, which contain cholesterol and significant levels of both triacylglycerols, from plant-derived residues, indicated by plant sterols, such as β-sitosterol, stigmasterol and campesterol, and only traces of triacylglycerols (Evershed 1993; Evershed et al. 1997a; Dudd and Evershed 1998). Barnard et al. (2007), however, have recently suggested that microorganisms living off residues can introduce β-sitosterol into residues resulting from the preparation of animal products. Waxes, which are long-chain fatty acids and long-chain alcohols that form protective coatings on skin, fur, feathers, leaves and fruit, also resist decay. Evershed et al. (1991) found epicuticular leaf waxes from plants of the genus *Brassica* in vessel residues from a Late Saxon/Medieval settlement. Cooking experiments later confirmed the utility of nonacosane, nonacosan-15-one and nonacosan-15-ol to indicate the preparation of leafy vegetables, such as turnip or cabbage (Charters et al. 1997). Reber et al. (2004) recently suggested *n*-dotriacontanol could serve as an effective biomarker for maize in vessel residues from sites located in Midwestern and Eastern North America. Beeswax can be identified by the presence and distribution of n-alkanes with carbon chains 23 to 33 atoms in length and palmitic acid wax esters with chains between 40 and 52 carbons in length (Heron et al. 1994; Evershed et al. 1997b).

Terpenoid compounds, or terpenes, are long chain alkenes that occur in the tars and pitches of higher plants. The use of GC and GC/MS to detect the diterpenoid, dehydroabietic acid, from conifer products in archaeological residues extends over a span of 25 years (Shackley 1982; Heron and Pollard 1988). Lupeol, α- and β-amyrin and their derivatives indicate the presence of plant materials (Regert 2007). Eerkens (2002) used the predominance of the diterpenoid, Δ–8(9)-isopimaric acid, in a vessel residue from the western Great Basin to argue it contained piñon resins. Other analytical techniques have also been used to identify terpenoid compounds. Sauter et al. (1987) identified the triterpenoid, betulin in Iron Age tar to confirm the tar was produced from birch. Azelaic acid is a short chain dicarboxylic acid is associated with the oxidation of unsaturated fatty acids (Regert et al. 1998).

Unsaturated fatty acids are most abundant in seed oils; its presence may indicate the residue reflects the processing of plant seeds.

The data obtained by HT-GC and HT-GC/MS analysis is useful for distinguishing plant residues, animal residues and plant/animal combinations. As noted above, the sterol cholesterol is associated with animal products; β-sitosterol, stigmasterol and campesterol are associated with plant products. The presence and abundance of triacylglycerols (TAGs) also varies with the material of origin. When present, amounts of TAGs tend to decrease with increasing numbers of carbon atoms in plant residues (Malainey et al. 2010, 2014, in press). The peak arising from C48 TAGs is largest and peak size (and area) progressively decreases with the C54 TAG peak being the smallest. A line drawn to connect the tops of the C48, C50, C52 and C54 TAG peaks slopes down to the right. This pattern is due to the preponderance of triacylglycerols with fatty acids having carbon chains ranging between 12 and 16 in length; C46 TAG peaks may also be detected. In animal residues, amounts of TAGs tend to increase with carbon numbers, with the C52 or C54 TAG peaks being the largest (Malainey et al. 2010, 2014, in press). A line drawn to connect the tops of the C48, C50, C52 and C54 TAG peaks either resembles a hill or the line slopes up to the right. A parabola-like pattern, such as the shape of a "normal distribution," can also occur in the residues of oil seeds that contain high levels of C18:1 isomers (Malainey et al. 2010, 2014, in press). This pattern is due to the abundance of triacylglycerols composed of fatty acids with mostly chain lengths of 16 or 18 carbons.

Methodology

Descriptions of the samples are presented in Table 4. Possible contaminants were removed by grinding off exterior surfaces with a Dremel® tool fitted with a silicon carbide bit. Immediately thereafter, the sample was crushed with a hammer mortar and pestle and the powder transferred to an Erlenmeyer flask. Lipids were extracted using a variation of the method developed by Folch et al.

(1957). The powdered sample was mixed with a 2:1 mixture, by volume, of chloroform and methanol (2 × 25 mL) using ultrasonication (2 × 10 min). Solids were removed by filtering the solvent mixture into a separatory funnel. The lipid/solvent filtrate was washed with 13.3 mL of ultrapure water. Once separation into two phases was complete, the lower chloroform-lipid phase was transferred to a round-bottomed flask and the chloroform removed by rotary evaporation. Any remaining water was removed by evaporation with benzene (1.5 mL); 1.5 mL of chloroform-methanol (2:1, v/v) was used to transfer the dry total lipid extract to a screw-top glass vial with a Teflon®-lined cap. The sample was flushed with nitrogen and stored in a -20°C freezer.

Preparation of FAMES

A 400 μL aliquot of the total lipid extract solution was placed in a screw-top test tube and dried in a heating block under nitrogen. Fatty acid methyl esters (FAMES) were prepared by treating the dry lipid with 3 mL of 0.5 N anhydrous hydrochloric acid in methanol (68°C; 60 min). Fatty acids that occur in the sample as di- or triglycerides are detached from the glycerol molecule and converted to methyl esters. After cooling to room temperature, 2.0 mL of ultrapure water was added; FAMES were recovered with petroleum ether (2 × 1.5 mL) and transferred to a vial. The solvent was removed by heat under a gentle stream of nitrogen; the FAMES were dissolved in 75 μL of *iso*-octane then transferred to a GC vial with a conical glass insert.

Preparation of TMS derivatives

A 75 or 200 μL aliquot of the total lipid extract solution was placed in a screw-top vial and dried under nitrogen. Trimethylsilyl (TMS) derivatives were prepared by treating the lipid with 70 μL of *N,O*-bis(trimethylsilyl)trifluoroacetamide (BSTFA) containing 1% trimethylchlorosilane, by volume (70ºC; 30 min). The sample was then dried under nitrogen and the TMS derivatives were redissolved in 100 μL of hexane.

Solvents and chemicals were checked for purity by running a sample blank. Traces of fatty acid contamination were subtracted from sample chromatograms. The relative percentage composition was calculated by dividing the integrated peak area of each fatty acid by the total area of fatty acids present in the sample. In order to identify the residue on the basis of fatty acid composition, the relative percentage composition was determined first with respect to all fatty acids present in the sample (including very long chain fatty acids) and second with respect to the ten fatty acids utilized in the development of the identification criteria (C12:0, C14:0, C15:0, C16:0, C16:1, C17:0, C18:0, C18:1ω9, C18:1ω11 and C18:2) (not shown). The second step is necessary for the application of the identification criteria presented in Table 2. It must be understood that the identifications given do not necessarily mean that those particular foods were actually prepared because different foods of similar fatty acid composition and lipid content would produce similar residues (see Table 3). It is possible only to say that the material of origin for the residue was similar in composition to the food(s) indicated. High temperature gas chromatography and high temperature gas chromatography with mass spectrometry is used to further clarify the identifications.

<u>Gas Chromatography Analysis Parameters</u>

The GC analysis was performed on a Varian 3800 gas chromatograph fitted with a flame ionization detector connected to a personal computer. Samples were separated using a VF-23 fused silica capillary column (30 m × 0.25 mm I.D.; Varian; Palo Alto, CA). An autosampler injected the sample using a split/splitless injection system. Hydrogen was used as the carrier gas with a column flow of 1.0 mL/min. Column temperature was increased from 80°C to 140°C at a rate of 20°C per minute then increased to 185°C at a rate of 4ºC per minute. After a 4.0 minute hold, the temperature was further increased to 250°C at 10°C per minute and held for 2 minutes. Chromatogram peaks were integrated using Varian MS Workstation® software and identified through comparisons with external qualitative standards (NuCheck Prep; Elysian, MN).

High Temperature Gas Chromatography and Gas Chromatography with Mass Spectrometry

Both HT-GC and HT GC-MS analyses were performed on a Varian 3800 gas chromatograph fitted with a flame ionization detector and a Varian 4000 mass spectrometer connected to a personal computer. For HT-GC analysis, the sample was injected onto a DB-1HT fused silica capillary column (15 m × 0.32 mm I.D.; Agilent J&W; Santa Clara, CA) connected to the flame ionization detector, using hydrogen as the carrier gas. The column temperature was held at 50°C for 1 minute then increased to 350°C at a rate of 15°C per minute and held for 26 minutes. For HT-GC/MS analysis, samples were injected onto a DB-5HT fused silica capillary column (30 m × 0.25 mm I.D.; Agilent J&W; Santa Clara, CA) connected to the ion trap mass spectrometer in an external ionization configuration using helium as the carrier gas. After a 1 minute hold at 50°C, the column temperature was increased to 180°C at a rate of 40°C per minute then ramped up to 230°C at a rate of 5°C per minute and finally increased to 350°C at a rate of 15°C per minute and held for 27.75 minutes. The Varian 4000 mass spectrometer was operated in electron-impact ionization mode scanning from m/z 50-700. Chromatogram peaks and MS spectra were processed using Varian MS Workstation® software and identified through comparisons with external qualitative standards (Sigma Aldrich; St. Louis, MO and NuCheck Prep; Elysian, MN), reference samples and the National Institute of Standards and Technology (NIST) database.

Results of Archaeological Data Analysis

Lipid compositions of the extracted residues are presented in Table 4. Fatty acid compositions of the residues were determined by using the area under the chromatographic peak of a given fatty acid, as calculated by the Varian MS Workstation® software minus the solvent blank. The term

"Area" represents the area under the chromatographic peak of a given fatty acid, as calculated by the Varian MS Workstation® software minus the solvent blank. Hydroxide or peroxide degradation products can interfere with the integration of the C22:0 and C22:1 peaks; these fatty acids were excluded from the analysis.

Insufficient fatty acids were present in residue 17UWM 1 to permit identification; in fact, it was almost completely devoid of fatty acids. Biomarkers were present, however. The animal sterol cholesterol was detected and the plant sterol β-sitosterol may occur.

The fatty acid compositions of three residues, 17UWM 2, 17UWM 3 and 17UWM 4 are characterized by high levels of C18:0, between 48.38% and 71.32%. High levels of C18:0 result from the preparation of large herbivores, such as bison, deer, moose, fat elk meat or other bovines or cervids; but javelina meat and tropical oil seeds also produce residues high in C18:0 and must be considered as potential sources where available. Levels of medium chain saturated fatty acids are low in all samples. The level of C18:1 isomers in residue 17UWM 2 is 10.72%, which indicates the meat was probably nicely marbled. Levels of C18:1 isomers are much lower, less than 3%, in both residues 17UWM 3 and 17UWM 4, which indicates that lean animal flesh was processed.

The animal sterol cholesterol was detected in residue 17UWM 2 and the plant sterol β-sitosterol may occur. Traces of triacylglycerols occurred in residue 17UWM 4; a larger C48 TAG peak and smaller C50 TAG peak were detected, which suggests the presence of plant material. No lipid biomarkers were detected in residue 17UWM 3.

On the basis of these results, both residues 17UWM 2 and 17UWM 4 likely reflect the preparation of large herbivore meat, possibly in combination with plants. Residue 17UWM 3 appears to result from the preparation of lean large herbivore flesh alone. Residue 17UWM 1 arose primarily from animal products but plant products may occur.

REFERENCES CITED

Barnard, H., A. N. Dooley and K. F. Faull
2007 Chapter 5: An Introduction to Archaeological Lipid Analysis by GC/MS. In *Theory and Practice of Archaeological Residue Analysis*, edited by H. Barnard and J. W. Eerkens, pp.42-60. British Archaeological Reports International Series 1650. Oxford, UK.

Charters, S., R. P. Evershed, A. Quye, P. W. Blinkhorn and V. Denham
1997 Simulation Experiments for Determining the Use of Ancient Pottery Vessels: Te Behaviour of Epicuticular Leaf Wax during Boiling of a Leafy Vegetable. *Journal of Archaeological Science* 24: 1-7.

Condamin, J., F. Formenti, M. O. Metais, M. Michel, and P. Blond
1976 The Application of Gas Chromatography to the Tracing of Oil in Ancient Amphorae. *Archaeometry* 18(2):195-201.

Dudd, S. N. and R. P. Evershed
1998 Direct demonstration of milk as an element of archaeological economies. *Science* 282: 1478-1481.

Eerkens, J. W.
2002 The Preservation and Identification of Pinon Resins by GC-MS in Pottery from the Western Great Basin. *Archaeometry* 44(1):95-105.

Evershed, R.P.
1993 Biomolecular Archaeology and Lipids. *World Archaeology* 25(1):74-93.

Evershed, R. P.
2000 Biomolecular Analysis by Organic Mass Spectrometry. In *Modern Analytical Methods in Art and Archaeology*, edited by E. Ciliberto and G. Spoto, pp. 177-239. Volume 155, Chemical Analysis. John Wiley & Sons, New York.

Evershed, R. P., C. Heron and L. J. Goad
1990 Analysis of Organic Residues of Archaeological Origin by High Temperature Gas Chromatography and Gas Chromatography-Mass Spectroscopy. *Analyst* 115:1339-1342.

Evershed, R.P., C. Heron and L.J. Goad
1991 Epicuticular Wax Components Preserved in Potsherds as Chemical Indicators of Leafy Vegetables in Ancient Diets. *Antiquity* 65:540-544.

Evershed, R. P., H. R. Mottram, S. N. Dudd, S. Charters, A. W. Stott, G. J. Lawrence, A. M. Gibson, A. Conner, P. W. Blinkhorn and V. Reeves
1997a New Criteria for the Identification of Animal Fats in Archaeological Pottery. *Naturwissenschaften* 84: 402-406.

Evershed, R. P., S. J. Vaugh, S. N. Dudd and J. S. Soles
1997b Fuel for Thought? Beeswax in Lamps and Conical Cups from Late Minoan Crete. *Antiquity* 71: 979-985.

Evershed, R. P., S. N. Dudd, M. J. Lockheart and S. Jim
2001 Lipids in Archaeology. In *Handbook of Archaeological Sciences*, edited by D. R. Brothwell and A. M. Pollard, pp. 331-349. John Wiley & Sons, New York.

Folch, J., M. Lees and G. H. Sloane-Stanley
1957 A simple method for the isolation and purification of lipid extracts from brain tissue. *Journal of Biological Chemistry* 191:833.

Frankel, E. N.
1991 Recent Advances in Lipid Oxidation. *Journal of the Science of Food and Agriculture* 54:465-511.

Heron, C., and A.M. Pollard
1988 The Analysis of Natural Resinous Materials from Roman Amphoras. In *Science and Archaeology Glasgow 1987. Proceedings of a Conference on the Application of Scientific Techniques to Archaeology, Glasgow, 1987*, edited by E. A. Slater and J. O. Tate, pp. 429-447. BAR British Series 196 (ii), Oxford.

Heron, C., N. Nemcek, K. M. Bonfield, J. Dixon and B. S. Ottaway
1994 The Chemistry of Neolithic Beeswax. *Naturwissenschaften* 81: 266-269.

Loy, T.
1994 Residue Analysis of Artifacts and Burned Rock from the Mustang Branch and Barton Sites (41HY209 and 41HY202). In: *Archaic and Late Prehistoric Human Ecology in the Middle Onion Creek Valley, Hays County, Texas. Volume 2: Topical Studies,* by R. A. Ricklis and M. B. Collins, pp. 607- 627. Studies in Archeology 19, Texas Archaeological Research Laboratory, The University of Texas at Austin.

Malainey, M. E.
1997 The Reconstruction and Testing of Subsistence and Settlement Strategies for the Plains, Parkland and Southern boreal forest. Unpublished Ph.D. thesis, University of Manitoba.

Malainey, M. E.
2007 Chapter 7: Fatty Acid Analysis of Archaeological Residues: Procedures and Possibilities. In *Theory and Practice of Archaeological Residue Analysis*, edited by H. Barnard and J. W. Eerkens, pp.77-89. British Archaeological Reports International Series 1650. Oxford, UK.

Malainey, M. E., M. Álvarez, I. Briz i Godino, D. Zurro, E. Verdún i Castelló and T. Figol
2014 The Use of Shells as Tools by Hunter-Gatherers in the Beagle Channel (Tierra del Fuego, South America): An Ethnoarchaeological Experiment. *Archaeological and Anthropological Sciences.* DOI: 10.1007/s12520-014-0188-1.

Malainey, M. E., P. J. Innes and T. J. Figol
2010 Taking a Second Look: Results of the Re-analysis of Archaeological Lipid Residues from North America and Beyond, Paper presented at the *75nd Annual Meeting of the Society for American Archaeology*, St. Louis, MO.

Malainey, M. E., P. Innes and T. Figol
in pressTaking a Second Look: A Functional Analysis of Burned Rock Features from Eight Sites in Texas and Arizona. Chapter prepared for a volume edited by H. Hoekman-Sites and M. Raviele to be published by the University of Colorado Press (40 pages).

Malainey, M. E., K. L. Malisza, R. Przybylski and G. Monks
2001a The Key to Identifying Archaeological Fatty Acid Residues. Paper presented at the *34th Annual Meeting of the Canadian Archaeological Association*, Banff, Alberta, May 2001.

Malainey, M. E., R. Przybylski and B. L. Sherriff
1999a The Fatty Acid Composition of Native Food Plants and Animals of Western Canada. *Journal of Archaeological Science* 26:83-94.

1999b The Effects of Thermal and Oxidative Decomposition on the Fatty Acid Composition of Food Plants and Animals of Western Canada: Implications for the Identification of archaeological vessel residues. *Journal of Archaeological Science* 26:95-103.

1999c Identifying the former contents of Late Precontact Period pottery vessels from Western Canada using gas chromatography. *Journal of Archaeological Science* 26(4): 425-438.

2001b One Person's Food: How and Why Fish Avoidance May Affect the Settlement and Subsistence Patterns of Hunter-Gatherers. *American Antiquity* 66(1): 141-161.

Malainey, M. E., R. Przybylski and G. Monks
2000a The identification of archaeological residues using gas chromatography and applications to archaeological problems in Canada, United States and Africa. Paper presented at *The 11th Annual Workshops in Archaeometry*, State University of New York at Buffalo, February 2000.

2000b Refining and testing the criteria for identifying archaeological lipid residues using gas chromatography. Paper presented at the *33rd Annual Meeting of the Canadian Archaeological Association*, Ottawa, May 2000.

2000c Developing a General Method for Identifying Archaeological Lipid Residues on the Basis of Fatty Acid Composition. Paper presented at the *Joint Midwest Archaeological & Plains Anthropological Conference*, Minneapolis, Minnesota, November 2000.

Marchbanks, M. L.
1989 Lipid Analysis in Archaeology: An Initial Study of Ceramics and Subsistence at the George C. Davis Site. Unpublished M.A. thesis, The University of Texas at Austin.

Patrick, M., A. J. de Konig and A. B. Smith

1985 Gas Liquid Chromatographic Analysis of Fatty Acids in Food Residues from Ceramics Found in the Southwestern Cape, South Africa. *Archaeometry* 27(2): 231-236.

Quigg, J. M., C. Lintz, S. Smith and S. Wilcox
2000 *The Lino Site: A Stratified Late Archaic Campsite in a Terrace of the San Idelfonzo Creek, Webb County, Southern Texas*. Technical Report No. 23765, TRC Mariah Associates Inc., Austin. Texas Department of Transportation, Environmental Affairs Division, Archaeological Studies Program Report 20, Austin.

Quigg, J. M., M. E. Malainey, R. Przybylski and G. Monks
2001 No bones about it: using lipid analysis of burned rock and groundstone residues to examine Late Archaic subsistence practices in South Texas. *Plains Anthropologist* 46(177): 283-303.

Reber, E. A., S. N. Dudd, N. J. van der Merwe and R. P. Evershed
2004 Direct detection of maize in pottery residue via compound specific stable carbon isotope analysis. *Antiquity* 78: 682-691.

Regert, M., H. A. Bland, S. N. Dudd, P. F. van Bergen and R. P. Evershed
1998 Free and Bound Fatty Acid Oxidation Products in Archaeological Ceramic Vessels. *Philosophical Transactions of the Royal Society of London, B* 265 (1409):2027-2032.

Regert, M.
2007 Chapter 6: Elucidating Pottery Function using a Multi-step Analytical Methodology combining Infrared Spectroscopy, Chromatographic Procedures and Mass Spectrometry. In *Theory and Practice of Archaeological Residue Analysis*, edited by H. Barnard and J. W. Eerkens, pp.61-76. British Archaeological Reports International Series 1650. Oxford, UK.

Sauter, F., E.W.H. Hayek, W. Moche and U. Jordis
1987 Betulin aus archäologischem Schwelteer. *Z. für Naturforsch* 42c (11-12):1151-1152.

Shackley, M.
1982 Gas Chromatographic Identification of a Resinous Deposit from a 6th Century Storage Jar and Its Possible Identification. *Journal of Archaeological Science* 9:305-306.

Skibo, J. M.
1992 *Pottery Function: A Use-Alteration Perspective*. Plenum Press, New York.

Solomons, T. W. G.
1980 *Organic Chemistry*. John Wiley & Sons, Toronto.

List of Tables

Table 1. Summary of average fatty acid compositions of modern food groups generated by hierarchical cluster analysis.

Cluster	**A**				**B**						**C**				
Subcluster	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**XIII**	**XIV**	**XV**
Type	Mammal Fat and Marrow	Large Herbivore Meat	Fish	Fish	Berries and Nuts	Mixed	Seeds and Berries	Roots	Seeds	Mixed	Greens	Berries	Roots	Greens	Roots
C16:0	19.90	19.39	16.07	14.10	3.75	12.06	7.48	19.98	7.52	10.33	18.71	3.47	22.68	24.19	18.71
C18:0	7.06	20.35	3.87	2.78	1.47	2.36	2.58	2.59	3.55	2.43	2.48	1.34	3.15	3.66	5.94
C18:1	56.77	35.79	18.28	31.96	51.14	35.29	29.12	6.55	10.02	15.62	5.03	14.95	12.12	4.05	3.34
C18:2	7.01	8.93	2.91	4.04	41.44	35.83	54.69	48.74	64.14	39.24	18.82	29.08	26.24	16.15	15.61
C18:3	0.68	2.61	4.39	3.83	1.05	3.66	1.51	7.24	5.49	19.77	35.08	39.75	9.64	17.88	3.42
VLCS	0.16	0.32	0.23	0.15	0.76	4.46	2.98	8.50	5.19	3.73	6.77	9.10	15.32	18.68	43.36
VLCU	0.77	4.29	39.92	24.11	0.25	2.70	1.00	2.23	0.99	2.65	1.13	0.95	2.06	0.72	1.10

VLCS- Very Long Chain (C20, C22 and C24) Saturated Fatty Acids
VLCU - Very Long Chain (C20, C22 and C24) Unsaturated Fatty Acids

Table 2. Criteria for the identification of archaeological residues based on the decomposition patterns of experimental cooking residues prepared in pottery vessels.

Identification	**Medium Chain**	**C18:0**	**C18:1 isomers**
Large herbivore	≤ 15%	≥ 27.5%	≤ 15%
Large herbivore with plant OR Bone marrow	low	≥ 25%	15% ≤ X ≤ 25%
Plant with large herbivore	≥ 15%	≥ 25%	no data
Beaver	low	Low	≥ 25%
Fish or Corn	low	≤ 25%	15% ≤ X ≤ 27.5%
Fish or Corn with Plant	≥ 15%	≤ 25%	15% ≤ X ≤ 27.5%
Plant (except corn)	≥ 10%	≤ 27.5%	≤ 15%

Table 3. Known food sources for different types of decomposed residues.

Decomposed Residue Identification	**Plant Foods Known to Produce Similar Residues**	**Animal Foods Known To Produce Similar Residues**
Large herbivore	Tropical seed oils, including sotol seeds	Bison, deer, moose, fall-early winter fatty elk meat, Javelina meat
Large herbivore with plant OR Bone marrow		
Low Fat Content Plant (Plant greens, roots, berries)	Jicama tuber, buffalo gourd, yopan leaves, biscuit root, millet	Cooked Camel's milk
Medium-Low Fat Content Plant	Prickly pear, Spanish dagger	None
Medium Fat Content (Fish or Corn)	Corn, mesquite beans, cholla	Freshwater fish, *Rabdotus* snail, terrapin, late winter fat-depleted elk
Moderate-High Fat Content (Beaver)	Texas ebony	Beaver and probably raccoon or any other fat medium-sized mammals
High Fat Content	High fat nuts and seeds, including acorn and pecan	Rendered animal fat (other than large herbivore), including bear fat
Very High Fat Content	Very high fat nuts and seeds, including pine nuts	Freshly rendered animal fat (other than large herbivore)

Table 4. Sample descriptions and lipid compositions of the pottery residues.

Fatty acid	17UWM 1		17UWM 2		17UWM 3 (dil)		17UWM 4	
	Area	Rel%	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	Insufficient Fatty Acids Detected to Permit Identification		32674	0.67	4926	0.06	4926	0.24
C14:0			83447	1.72	28670	0.35	28670	1.41
C15:0			48867	1.01	40135	0.50	40135	1.58
C16:0			1346553	27.70	1589351	19.68	1589351	43.29
C16:1			11832	0.24	2557	0.03	2557	0.51
C17:0			167128	3.44	318554	3.94	318554	0.00
C17:1			6069	0.12	0	0.00	0	0.68
C18:0			2440518	50.21	5760434	71.32	5760434	48.38
C18:1s			521091	10.72	221897	2.75	221897	2.19
C18:2			53091	1.09	2281	0.03	2281	0.64
C18:3s			6038	0.12	0	0.00	0	0.78
C20:0			120921	2.49	101207	1.25	101207	0.00
C20:1			16389	0.34	4651	0.06	4651	0.09
C24:0			6465	0.13	2780	0.03	2780	0.13
C24:1			0	0.00	0	0.00	0	0.08
Total			4861083	100.00	8077443	100.00	12605901	100.00
Biomarkers	Cholesterol; possibly β-sitosterol		Cholesterol; possibly β-sitosterol		None detected		None detected	
Triacyl-glycerols	None detected		None detected		None detected		Traces detected; larger C48 TAG and smaller C50 TAG Plant products present	
Identification	Animal products, plants may be present		Large herbivore flesh; plants may be present		Lean large herbivore flesh		Lean large herbivore flesh; plants may be present	
Sample	1		2		3		4b	
Vessel No.	3021		2002		3022		2019	
DCID	3021100		200273		302210		201906	
Description	Early Woodland Dane Incised body sherd		Late Woodland Havana Zoned body sherd		Early Woodland Dane Punched body sherd		Late Woodland Deer Creek Incised rim sherd	
Mass	8.605 g		10.046 g		10.676 g		12.866 g	

Appendix K. Listing of Formulas Used for the Plant Macroremain and Faunal Analyses

Code	Description	Formula
a	Raw abundance count (c) or weight (w)	--
c	Raw count	--
d	Density ratio	$d=(a/s)*10$
f	Total plant food weight of the assemblage	--
H'	Shannon-Weaver Diversity Index	$H' = -\sum (p_i)(\mathrm{Log}_{10} p_i)$
g	Fragmentation Ratio	g=a/NISP
ln	log	--
p	Relative abundance of the *i*th taxon within the sample	--
q	Plant food ratio	$q=a/f$
S	Richness - total number of taxa present in a sample	--
t	Total number of contexts	--
U	Ubiquity ratio	$U=x/t$
V'	Equitability	$V'=H'/_{\log}S$
w	Raw weight	--
x	Number of contexts in which a taxa is present	--

Appendix L. Raw Data for the Nutshell

Early Woodland

Feature	Nutshell Count	Nutshell Weight (g)	Total Plant Weight (g)	Ratio Nutshell Count:Nutshell Weight	ln (Nutshell Count: Nutshell Weight)
66	5	0.03	0.03	185.19	5.22
68	19	0.22	0.23	81.20	4.40
81	14	0.08	0.09	157.30	5.06
83	15	0.34	0.34	43.86	3.78
84	1	0.01	0.01	166.67	5.12
93	6	0.11	0.11	54.55	4.00
581	5	0.16	0.16	31.25	3.44
	65	0.95	0.97	67.15	4.21

Middle Woodland

Feature	Nutshell Count	Nutshell Weight	Total Plant Weight	Nutshell Count/ Nutshell Weight	ln (Nutshell Count/ Nutshell Weight)
37	2	0.036	0.038	52.632	3.963
41	1	0.008	0.015	66.667	4.200
47	4	0.070	0.070	57.143	4.046
48	4	0.004	0.004	1000.000	6.908
82	8	0.160	0.160	50.000	3.912
88	3	0.039	0.044	68.182	4.222
96	18	0.326	0.490	36.735	3.604
97	2	0.013	0.034	58.824	4.075
100	2	0.010	0.010	200.000	5.298
103	2	0.027	0.027	74.074	4.305
114	21	0.259	0.259	81.081	4.395
121	60	0.554	0.562	106.762	4.671
146	8	0.131	0.131	61.069	4.112
168	3	0.018	0.018	166.667	5.116

Appendix M. Raw Data for the Mammal Remains

Component	Feature	Count	Weight (g)	ln (*c*)	ln (*w*)
Early Woodland	17	12	1.67	2.485	0.513
Early Woodland	34	1	0.02	0.000	-3.912
Early Woodland	65	1	8.39	0.000	2.127
Early Woodland	81	138	48.42	4.927	3.880
Early Woodland	83	125	18.83	4.828	2.935
Early Woodland	84	2	1.91	0.693	0.647
Early Woodland	93	1	0.06	0.000	-2.813
Early Woodland	581	104	36.74	4.644	3.604
Middle Woodland	82	78	33.23	4.357	3.503
Middle Woodland	95	192	107.46	5.257	4.677
Middle Woodland	103	5	0.25	1.609	-1.386
Middle Woodland	114	26	2.56	3.258	0.940
Middle Woodland	120	2	0.46	0.693	-0.777
Middle Woodland	129	281	172.92	5.638	5.153
Middle Woodland	146	2	1.02	0.693	0.020
Middle Woodland	167	53	16.82	3.970	2.823

Appendix N. Raw Data for the Wood Charcoal

Component	Feature	Count	Weight (g)	Liters	Density Ratio (*d*) (weight: liters)	ln (*d*)
Early Woodland	12	16	0.1	3	0.033	-3.401
Early Woodland	68	3	0.026	5	0.005	-5.259
Early Woodland	81	1	0.01	80	0.000	-8.987
Early Woodland	83	13	0.153	10	0.015	-4.180
Early Woodland	93	14	0.131	6	0.022	-3.824
Early Woodland	94	5	0.035	9	0.004	-5.550
Middle Woodland	37	16	0.151	9	0.017	-4.088
Middle Woodland	41	10	0.06	4	0.015	-4.200
Middle Woodland	47	5	0.036	5	0.007	-4.934
Middle Woodland	48	19	0.131	16	0.008	-4.805
Middle Woodland	82	17	0.188	8	0.024	-3.751
Middle Woodland	88	20	0.145	6	0.024	-3.723
Middle Woodland	96	88	0.952	18	0.053	-2.940
Middle Woodland	97	115	0.608	4	0.152	-1.884
Middle Woodland	100	2	0.013	8	0.002	-6.422
Middle Woodland	114	3	0.011	8	0.001	-6.589
Middle Woodland	120	5	0.046	7	0.007	-5.025
Middle Woodland	121	41	0.315	8	0.039	-3.235
Middle Woodland	146	14	0.205	4	0.051	-2.971
Middle Woodland	168	2	0.032	9	0.004	-5.639
Middle Woodland	2001	1	0.053	3	0.018	-4.036

JENNIFER R. HAAS

EDUCATION

Doctor of Philosophy in Anthropology, University of Wisconsin-Milwaukee (2019)
Master of Arts in Anthropology, University of South Carolina (1995)
Bachelor of Arts in History; Bachelor of Arts in Anthropology, Marquette University (1992)

PROFESSIONAL QUALIFICATIONS

Meets the *Secretary of Interior's Professional Qualifications Standards* for Archaeology (Prehistoric and Historic Periods) and History (48FR44738-9)

Qualified archaeologist to excavate and analyze human burials under Wisconsin's burial law and administrative rules (Wis. Stats. § 157.70(1) (i) and HS 2.04(6))

OVERVIEW OF ADMINISTRATIVE & MANAGEMENT EXPERIENCE

Generated $5 million of funded cultural resource management projects for fiscal years 2014-2018 for the Cultural Resource Management program at UWM

Owned and operated a successful, for-profit cultural resource management firm (2001-2014) with average annual gross receipts of $900,000

Concurrently manage multiple cultural resource projects, averaging three hundred per year, for the transportation, energy, development, federal (military), and energy/utility industries that require compliance with Section 106 of NHPA, NEPA, as well as state-level compliance (WI, MN, MI, ND, IL)

Direct and manage a full time staff of ten Principal Investigators, Archaeologists, Architectural-Historians, Specialists, and up to fifty limited term archaeological field and laboratory technicians

Expert in Section 106 (NHPA), NEPA, 4f (Transportation), Wisconsin DOT (Facilities Development Manual), FERC, Wisconsin DNR, and Wisconsin Statute 44.40 and 157.70 (burial related) procedures and policies

Regular participant in on-going training and education for Cultural Resource Management including *4(f) for Historic Properties*, *Traditional Cultural Properties, Writing Memorandum of Agreements and Programmatic Agreements*, *Section 106: Working with the Revised Regulations*, and *WisDOT Training for Historical Consultants*.

PROFESSIONAL EXPERIENCE: CULTURAL RESOURCE PROJECT MANAGEMENT

Burial Sites Specialist: Documented, researched, and excavated prehistoric and historic American Indian, and historic Euroamerican human burial sites and cemeteries to assist federal agencies, state agencies, utility companies, and private clients relative to compliance with Wisconsin Statute 157.70. Gubernatorial appointee on the Wisconsin Burial Sites Preservation Board (2013 to present)

Cultural Resources Specialist. Extensive experience in preparation of archaeological Data Recovery Plans, Finding of Effect Documentation, Documentation for Consultation, Memorandum of Agreements, draft EIS, Historic Resources Management Plans, Programmatic Agreements, and consultation efforts (tribal & stakeholder) for large scale transportation, utility, and energy projects relating to archaeological sites, historic structures, and districts.

Phase I Archaeological Surveys. Directed Phase I field survey of over 350 complex transportation and utility corridors, development sites, and energy projects (WI, MN, ND, MI, IL, OH), and prepared technical reports

Phase II Archaeological Evaluations. Directed field excavations and laboratory analyses, and primary author, for fifty National Register evaluations (Phase II) of archaeological sites in (WI, MN, ND) encompassing components from the Paleoindian, Archaic, Woodland, and historic periods

DOEs. Prepared Determination of Eligibility (NPS-Form 10-900) and state Determination of Eligibility forms for prehistoric and historic archaeological sites, historic navigation structures, and historic structures in Midwest (WI, MN, ND, MI)

Phase III Mitigation. Directed field excavations and laboratory analyses, and primary author, for twenty large-scale data recovery (Phase III) projects (WI, MN, ND), encompassing components from the Paleoindian, Archaic, Woodland, and historic periods

Specialty Skills. Bioarchaeologist, Paleoethnobotanist, and Geographical Information Systems specialist

PRESENTATIONS & OUTREACH

Authored over five hundred cultural resource management reports relating to results of Phase I surveys, Phase II evaluations studies, complex data recovery projects, and historic structures documentation and context.

Published articles in *Wisconsin Archaeologist*.

Presented papers at Midwest Archaeological Conference (1993, 1995, 2012, 2016, 2018), Plains Anthropological Conference (1996) and Society for American Archaeology Conference (2013, 2016, 2017)

Invited discussant for *Least Cost Path to Reduce the Gender Gap: Female Voices Contributing to GIS and Remote Sensing in Archaeology* at the SAA 83rd Annual Meeting in Washington, DC (April 11 - 15, 2018)

PROFESSIONAL HISTORY

Principal Investigator, Cultural Resource Management, University of Wisconsin-Milwaukee (2014 to present)

Board Member, Wisconsin Burial Sites Preservation Board-Wisconsin Historical Society (2013 to present)

Board Member, Wisconsin Archeological Survey (2015 to present)

President & Owner of Great Lakes Archaeological Research Center, a cultural resource management firm located in Milwaukee, Wisconsin (2001 to 2014)

Adjunct Faculty, Marquette University, Milwaukee, Wisconsin (2008 to 2009)

Associate Director, Center for Archaeological Research at Marquette University, Milwaukee, Wisconsin (1999 to 2001)

Principal Investigator, Great Lakes Archaeological Research Center, Milwaukee, Wisconsin (1997 to 1999)

Archaeologist, Institute for Minnesota Archaeology Consulting, Minneapolis, Minnesota (1996 to 1997)

Archaeologist, Great Lakes Archaeological Research Center, Milwaukee, Wisconsin (1994 to 1996)

Archaeological Field Technician, Great Lakes Archaeological Research Center, Milwaukee, Wisconsin (1992 to 1994)

Research Assistant, University of South Carolina, Columbia (1993 to 1994)