# EXPLORING A BIOCULTURAL MODEL OF RESILIENCY IN THE LOWER ILLINOIS RIVER VALLEY FROM MIDDLE TO LATE WOODLAND PERIODS

by

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**TABLE OF CONTENTS**

## LIST OF TABLES

**Table** **Page**

## LIST OF FIGURES

**Figure** **Page**

## LIST OF ABBREVIATIONS

| Abbreviation | Description |
| --- | --- |
| SES | socioecological system |
| LEH | linear enamel hypoplasia |
| LIV | lower Illinois River Valley |
| INNA | instrumental neutron activation analysis |
| FBL | femoral bicondylar length |
| TML | tibial maximum length |
| CAA | Center for American Archeology |
| EZ | Elizabeth |

## ABSTRACT

The purpose of this study was to describe and explore a biocultural model of resilience, and to test how Resilience Theory could be applied to small-scale prehistoric populations. In order to accomplish these goals, the adult Middle and Late Woodland skeletons from the Elizabeth site in west central Illinois were examined for the non-specific stress indicators of linear enamel hypoplasia, tibial periostosis, and changes to average stature. Both adult and non-adult Middle and Late Woodland burial contexts from the Elizabeth site were also examined in terms of burial posture and grave good inclusion. Meaningful patterns were identified using basic quantitative and qualitative methods within and across temporal periods by both biological sex and age cohorts. While the population appears to be in equilibrium from the Middle to Late Woodland periods from the perspective of "stress", the regular trend from Middle to Late Woodland period in the lower Illinois River Valley is for increasing population size with decreasing inter-regional interactions. The changes in socio-cultural burial practices indicates an increase in connectedness at the Elizabeth site that, when paired with rising biological potential via increasing population and stable settlement patterns, signals a growing, resilient population leading into the conservation stage of the Adaptive Cycle.

# I. THE BEGINNING, END, AND EVERYTHING IN BETWEEN

The general concept of applying ecological principles to human populations is not new (Park 1936; Steward 1938). However, more recent decades have seen increased numbers of ecological interpretative models explicitly applied to anthropological contexts (for broader discussion see Sutton and Anderson 2014). One such concept resilience, which is defined by Faulseit (2016: 6) as a group's vulnerability and its "ability to adapt to, cope with, or transform when facing both acute and chronic stresses." Resilience will be discussed in greater detail in Chapter II, but a brief definition of the theory is a framework to view the ways ecosystems and the living populations within can maintain homeostasis or adapt to internal/external agents of change (Holling 1973). Resilience, as used in this paper was first conceptualized by Holling in 1973 in tracing environmental changes through time and the effects of those changes on the plant and animal populations in the Great Lakes of the United States. Decades later Holling's ideas were applied to human groups (Allen et al. 2014; Carpenter et al. 2001; Crane 2010; Faulseit 2016; Hegmon et al. 2008; Redman 2005; Redman and Kinzig 2003; Walker et al. 2004). Archaeologists have used the concept of resilience to describe the potential ways that communities move through different ecological phases of a socioecological system (SES). Even more recently, biological anthropologists and bioarchaeologists have attempted to conceptualize and contextualize the idea of "health" through the lens of resilience in order to describe past lifeways (DeWitte et al. 2016; Hoover and Hudson 2016; Temple and Stojanowski 2019). These applications of resilience models do not aim to explain a final result, but instead try to describe possible ways in which a result occurred.

Resilience, as it is currently modelled, is a reflection of changes in biological potential and social connectedness. The variables of linear enamel hypoplasia (LEH), tibial periosteal reactions, and achieved stature were selected for this study because they are non-specific stress indicators (Chapter V). They also have been used to describe populations from the lower Illinois River Valley in foundational bioarchaeological research (Chapter II) (Buikstra 1976; Buikstra 1981; Cook and Buikstra 1979; Cook 1981, 1984). In these studies, LEH and stature (amongst other variables) were used to describe differences in social statuses based on differential access to resources during skeletal and dental development. Later, when the transition to agriculture in the Midwest became a more central focus of bioarchaeological research, research models frequently included a more diverse array of non-specific stress indicators in order to model factors such as disease and biomechanical loads in a population (see discussion in Cook 1984). The models from Buikstra (1976), Cook and Buikstra (1979), and Cook (1981 and 1984) were foundational in future studies by connecting skeletal biology to social practices.

The Osteological Paradox by Wood et al. (1992), extended the discourse of frailty and vulnerability and also provided a platform for interpreting survivorship and resilience was created. As such, non-specific stress indicators such as LEH, stature, and periosteal reactions that were used to discuss "stress" within and between social groups in models such as Buikstra (1976), Cook and Buikstra (1979), and Cook (1981 and 1984) are valuable as proxies for discussing both biological potential and social connectedness for models such as the Adaptive Cycle from Resilience Theory.

While these works have made great strides to clarify, conceptualize, and contextualize several lines of evidence—both archaeological and biological—further detailed explorations of socioecological perspectives on resilience, such as those found in Faulseit (2016) and Temple and Stojanowski (2019) are considered. As the name implies, this perspective includes both socio-cultural and ecological/biological principles. By examining both ends of a socio-cultural and biological spectrum, changes made both consciously and unconsciously form measurable patterns through time, and this project was thus proposed in order to demonstrate a potential model of resilience that is biocultural in nature. By employing both archaeological and biological anthropology elements, a model for resilience was developed and applied by observing both cultural and physiological changes between the Middle and Late Woodland Periods (ca. cal A.D. 400-1000) in the lower Illinois River Valley at the Elizabeth site. When considering the Middle to Late Woodland time periods and their transition, Resilience Theory should be able to describe the currents leading from one period to the next, and to changes in socio-cultural practices, and therefore biological changes. More specifically, this study focuses on how human populations are physiologically and socio-politically resilient, and how a resilient community is distinguished from a community under “stress”. For the purpose of this exercise, stress is measured by the frequency of LEHs, the frequency and status of tibial periostosis reactions, and the change in average achieved stature of adults.

The variables of LEH and achieved stature were used in this study as proxies for resource availability during skeletal development, while tibial periosteal reactions were used as a proxy for disease and/or trauma load for the Elizabeth site population. When contextualized with changes in social practices as proxied by the mortuary variables of body posture and presence of grave goods, as well as previous archaeological and mortuary research, changes in the population’s biological potential and social connectedness are described through the Adaptive Cycle framework.

In order to identify meaningful patterns and to explore a foundational biocultural model of resilience five questions were proposed:

1. Is there a change in frequency of linear enamel hypoplasias (LEHs) from the Middle to Late Woodland periods?
2. Is there a change in frequency of periostosis of the tibiae from the Middle to Late Woodland periods?
3. Is there an increase or decrease in average stature from the Middle to Late Woodland periods?
4. Are there trends in mortuary practices that correlate with LEH, periostosis and/or stature?
5. Do linear enamel hypoplasias (LEHs), periostosis, stature, and burial practices show patterning across time?

The following chapters will first describe the study region and site (Chapter II) before discussing the theoretical framework of Resilience (Chapter III) that will act as the framework for this exercise. A brief summary of relevant mortuary theory is presented in Chapter IV. Next, the materials and methods used in this study will be detailed (Chapter V) before the results of quantitative analyses are presented (Chapter VI). The qualitative results will then be contextualized into a broader discussion of Woodland practices at the Elizabeth Site in order to describe any significant, identifiable patterns (Chapter VII), which may indicate whether the population can be described as resilient or not. Conclusions and future directions will then be considered in Chapter VIII.

## II. THE WOODLANDS OF THE LOWER ILLINOIS RIVER VALLEY

**The lower Illinois River Valley Environment and Chronology.** The lower Illinois River Valley consists of the area of land along the Illinois River 70 miles from its confluence with the Mississippi (Figure 1).

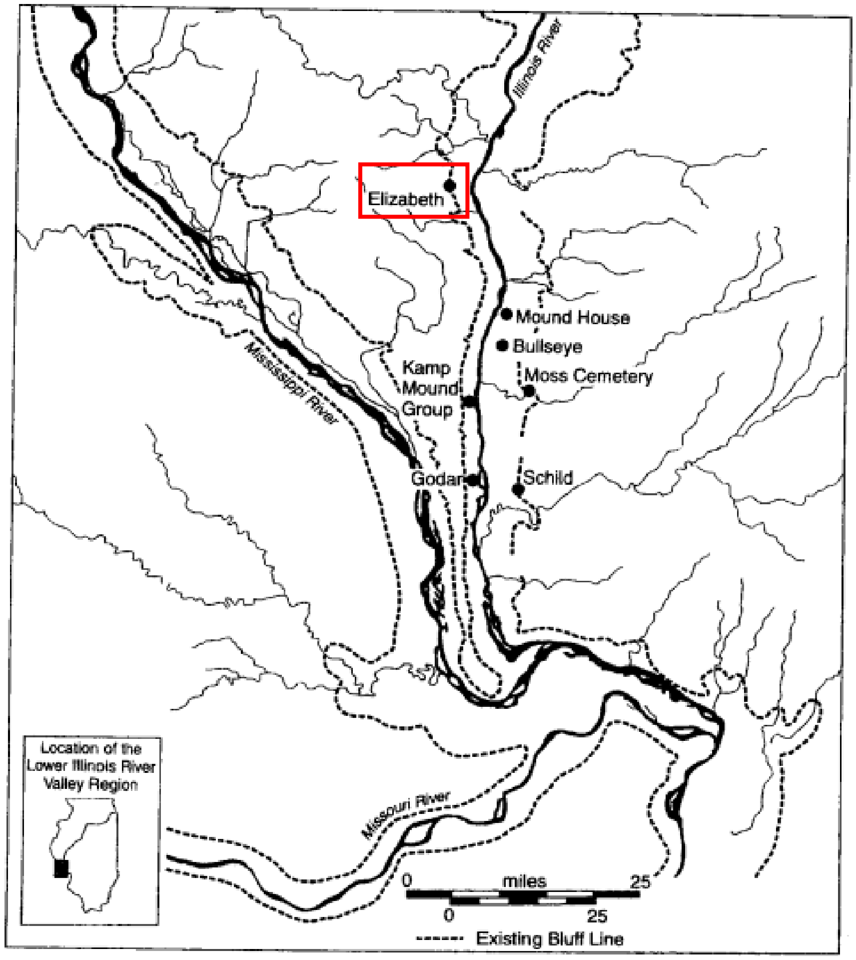


Figure 1. The lower Illinois River valley with the Elizabeth Site highlighted from Buikstra and Charles (1999).

The valley spans approximately 20 miles east/west at its widest point from the Illinois to Mississippi rivers (Buikstra 1976). Bordered by limestone bluffs carved out by the rivers and in part by glaciers, the locations of habitation and multi-community gathering sites are numerous on both the blufftops, as well as within the floodplains. This region contains several smaller valleys, uplands and forests subject to a temperate climate and enriching flood episodes that were suitable for habitation and the development of complex lifeways throughout prehistory.

A general timeline of temporal phases for the modern state of Illinois can be found in Table 1 (King 2016; King et al. 2011; Milner 2004).

**Table 1. General timeline of modern-day Illinois prehistory**

| Temporal Component | Date Range |
|---|---|
| Archaic | 8000-1000 B.C. |
| Early Woodland | 1000-50 B.C. |
| Middle Woodland | 50 B.C. – A.D. 400 |
| Late Woodland | A.D. 400 – 1000 |
| Mississippian | A.D. 1000 – 1300 |

The lower Illinois River Valley (LIV) site chronology generally ranges from the Middle Archaic through Mississippian periods (approximately 8000 B.C. to A.D. 1300). A few sites with Early Archaic components are well preserved and documented, such as at the Koster site (Buikstra 1981; Farnsworth and Emerson 1986; Wiant et al. 1983; Wiant et al. 2009). The patterns of Mississippian culture in the LIV do not fit well within the context of the rest of the state as characteristics of the Late Woodland culture persist well into the Mississippian period documented in the Central Illinois Valley to the north, and in the American Bottom Region to the south (Charles 1992; Farnsworth et al. 1991).

The Archaic occupations (~8000-1000 B.C.) throughout the valley can be characterized as a period of cyclical experimentation and exploitation of seasonal resources (Buikstra and Charles 1999). As floodplain productivity increased through this time period, so too did sedentism likely due to resource availability (Buikstra and Charles

1999). Generally, the peoples of this broad time period relied on highly mobile foraging patterns, but what is evidenced through the known camp sites, and the increasingly well-preserved burial sites, is that the population progressively increased (Charles et al. 1988; Emerson et al. 2000; Farnsworth and Emerson 1986; Milner 2004). Originally, it was believed that a majority of the Archaic sites in the lower valley belonged to the Middle and Late Archaic periods dating from about 6000-1000 B.C. During this period, it appears that the single village may have been the basic economic unit with little social differentiation (Farnsworth and Emerson 1986). However, more comprehensive examinations of Archaic period sites in the lower Valley has led to a more nuanced understanding of Archaic lifeways (Styles and McMillan 2009; Wiant et al. 2009). From the Early to Middle Archaic periods, short-term residential encampments sites were regularly reoccupied and centered around hearths. By ~7000 B.P., in the middle-Middle Archaic period, base settlements with storage and food-processing pits have been documented and evidence for a more sedentary settlement pattern than in the previous period (Wiant et al. 2009). Subsequently, through the progression of the Middle Archaic period, base camps likely shifted into more seasonal, residential camps that persisted into the Late Archaic period; although much less has been described about Late Archaic settlement patterns (Styles and McMillan 2009; Wiant et al. 2009). While generally multiple individuals were interred within large pits or small mounds, burial treatment was not significantly different between adult and non-adult individuals, but where grave goods do occur, they are only cached with non-adults during the Early and early-Middle Archaic periods (Farnsworth and Emerson 1986; Wiant et al. 2009). However, by the middle-Middle Archaic period and throughout the Late Archaic period a dramatic increase in mortuary variation occurred with increased evidence for ritual via careful treatment of remains and inclusion of grave goods, such as bone and stone tools, rather than the expedient group burials (Wiant et al. 2009). For example, the Archaic burial series of the Koster site's Horizons VI and VII in the LIV demonstrate differential treatment of individuals when adult individuals demonstrating bony pathology that would have likely inhibited subsistence activities were excluded from blufftop cemetery burials, and instead were buried in middens at habitation sites (Buikstra 1981; Emerson et al. 2000; Farnsworth and Emerson 1986).

The Archaic phases could be described as periods of experimentation not only in mortuary practices but also through general lifeways as floral evidence may indicate some early plant domestication (Emerson et al. 2000; Farnsworth and Emerson 1986). The cultural period of the Archaic being during the Late Holocene, the climate of the valley would have become increasingly productive with the spread of grassland environments and in turn healthy, flowing rivers to support many drought resistant plants along the bluffs and within the floodplains (Charles 2012; Farnsworth and Emerson 1986; Kidder 2006; Wiant et al. 2012). However, it has also been hypothesized that these gradual climatic changes, in turn, became debilitating to the lifeways of those in the valley as flood frequency and magnitude increased, likely largely contributing to settlement abandonment not just in the valley but throughout most of eastern North America (Charles 2012; Kidder 2006). Abandonment of the lower Illinois River Valley is further supported by the few Early Woodland (1000 – 50 B.C.) sites found generally at the northern part of the valley (Charles 2012; Emerson et al. 2000; Farnsworth and Emerson 1986; Kidder 2006; King et al. 2011).

General, cultural trends for the period of abandonment can be found in discussions of sites in the central Illinois River Valley (Buikstra and Charles 1990; Charles 1985, 1992, 1995; Farnsworth 1986; Farnsworth and Emerson 1986; Emerson et al. 2000; Wiant et al. 2009). However, in the lower Illinois River Valley residential models and artifactual trends have demonstrated that reoccupation of the valley began around 50 B.C. with distinct influences from the central valley (Buikstra and Charles 1999; Charles 1985, 1992, 1995; Farnsworth and Asch 1986; King 2017). By the end of the Early Woodland period and during the Early-Middle Woodland period, the climate had stabilized sufficiently for occupation of the lower river valley; however, the likely complex causes for resettlement lie outside the scope of this project. A larger, more formal overview of the central and lower river valleys would be interesting especially when considering the frameworks of resilience, transformation, and collapse.

Returning to the LIV, the Middle Woodland (50 B.C. – A.D. 400) phase witnessed an early migration of people from the central Illinois River valley to the northern part of the valley (Charles 1992, 1995; King et al. 2011). The Middle Woodland period, occasionally referred to as Hopewell, is the most well documented cultural period for the region (Buikstra 1976; Buikstra and Charles 1999; Buikstra et al. 1998; Caldwell and Hall 1964; Carr 2005; Charles 1992; Charles 2012; Charles and Buikstra 2002; Charles et al. 1988; Deuel 1952; Fie 2008; Griffin 1952; Morgan 1985, 1986; Neiman 1995; Perino et al. 2006; Struever 1960; Wiant and McGimsey 1986). From these studies—and a multitude of others—a grand picture of a Hopewell Phenomenon has been painted that has sparked countless other areas of research throughout the eastern woodlands. The Hopewell Phenomenon has been described and defined in a number of ways throughout the years based on temporal horizons, artifact styles, as a burial or ancestral cult, and as an interaction sphere to name a few (Carr 2005; Charles and Buikstra 2002; Deuel 1952; Perino et al. 2006; Struever 1964). Most recent literature has tried to broaden the scope into a more holistic description of the Middle Woodland by focusing less on the trade network to describing a period of locally diverse horticulturalists/gatherer-hunters with structured burial practices in ramp and tomb style mounds including elaborate grave goods with some trade (Buikstra 1976; Buikstra and Charles 1999; Charles et al. 1988; Fie 2008; Perino et al. 2006; King et al. 2011; Struever 1964). Many variations of "Hopewell" have been described across the eastern woodlands (see Struever 1964); however, these broad characteristics are the general defining characteristics. In the lower river valley, Middle and the subsequent Late Woodland sites are found on both the bluff tops and within the floodplains of the valley. Floodplain sites are typically larger in scale than the contemporary bluff top sites and were locations for multi-community gatherings for exchange and ceremony (Buikstra et al. 1998; Charles 1992; Charles and Buikstra 2002; King et al. 2011; Struever 1960;).

The Late Woodland period has, in the past, been described as a decline or a degeneration from the Middle Woodland/Hopewell period (Emerson et al. 2000; Kerber 1983; Kerber 1986;). This description, which is now widely criticized, was based on an obvious change in artifact style, discontinuation of the broad trade network, and shifts in mortuary practices (Charles 1992; Charles and Buikstra 2002; Emerson et al. 2000; Kerber 1983; Kerber 1986). While the changes in material goods are the most obvious indicators of a cultural shift, many less obvious changes occurred during this time period that could be described as progressive, such as an increase in horticultural practices with a gradually developing maize agriculture at the end of the cultural period, or the creation of many new mortuary tracks like the use of crematories and greater variability of burial timing during mound construction phases (Asch and Asch 1985; Asch and Asch 1986; Asch, Farnsworth, and Asch 1979; Buikstra and Milner 1991; Emerson 2000; Fritz 1990, 2019; Hedman and Emerson 2008; Kerber 1983; Kerber 1986; Milner 2004; Mueller 2012; Rose 2003; Rose 2008; VanDerwarker, Wilson, and Bardolph 2013).

**Mounds and mound-building.** The mounds of North America have interested historic and archaeological investigators since the discovery of the New World (for a broad summary of mound-building cultures see Milner 2004). Evidence for the development of mound-building practices in west central Illinois appears as early as the Late Archaic period (see above). In the lower Illinois River Valley, two distinct locations are used for the construction of mound groups—bluff top ridges and valley floodplains. The bluff top mound groups represent local, community cemeteries, while the larger floodplain mound groups that appear in the Middle Woodland period represent multi-community or regional interaction centers (Buikstra and Charles 1999; Buikstra, Charles, and Rakita 1998; Charles et al. 1988; Ruby, Carr, and Charles 2005; Wiant and McGimsey 1986). The mound groups, consisting of several structures of varying size, not only serve as a place to bury the dead, and locations for community or multi-community meetings, but they also hold a powerful meaning for the people who built them. In 1981 and 1997, Robert Hall linked the practice of mound-building to the story of Earthdiver. It was his belief that the practice of building and using the mounds was a way to retell, or recreate, the story of Earthdiver. The essence of these tales is that in the beginning the world was a vast sea with no land for creatures to stand. When the space being inhabited by all these beings became too crowded, they were ordered to go down and explore the sea one by one in the hopes to solve their problem. Many would try, however, only one would eventually succeed and there is no set prescription as to what creature would be successful. For the Cherokee, it was water beetle, the Chickasaw say crawfish, and the Iroquois and Maidu say turtle (Erdoes and Ortiz 1984; Zimmerman 2011). The mud these creatures brought up would proliferate and would eventually be formed into the land that people stand upon today.

The significance of the earthdiver myth to the creation of mounds and a new world for the deceased is further demonstrated by the burial of artifacts such as pottery that is decorated with images of waterfowl, as well as the bodies of water fowl such as the roseate spoonbill. These birds exist upon the earth, on top of the water, and within the sky. In certain telling of the earthdiver myth, these forms of birds eventually succeed in bringing up the mud from the bottom of the sea (Berezkin 2007; Köngäs 1960; Reichard 1921). Images of water birds on ceramic vessels, such as the roseate spoonbill and cranes, appear throughout the lower Illinois River Valley's burials such as at the Pete Klunk Mound 7, and the Gibson Mound 3 (see Buikstra 1976; Charles et al. 1988; Perino 2006).

After closely linking the earthdiver myth to the practice of moundbuilding, Hall then continued to move forward in time to observe and describe the Plains People's Sun Dance as a continuation of this connection of Earthdiver and world renewal to include the development of the Sun Dance—a commonly known renewal ceremony (Hall 1997). However, in his writing, Hall never explicitly describes the interaction between the world of the living and the dead. On one hand, moundbuilding was conducted in part for the passage of the deceased into the next world; whereas, the Sun Dances were performed for the living to restore balance to the current world. The slightly disconnected ideas from Hall's conceptualization of moundbuilding represented a distinct breakthrough for mound research because the meanings for the construction of the mounds, themselves, had been clarified significantly. Shortly after his publications, Hall's thoughts were integrated by Buikstra and Charles (1999) in their discussion on ancestorhood and its significance in the realms of the living and the dead.

**Materials and models surrounding the mounds.** The Hopewell tradition is differentiated based on the scale of study from the interregional to local levels. The interregional level can be thought of as a corporate ceremonial sphere, while the local level refers to the domestic domain (Buikstra 1976; Buikstra and Charles 1999; Charles 1995; Carr 2005). The differences in scope allows for distinction of groups within the umbrella of "Hopewell" based on locality, made based on differences in subsistence-settlement patterns, material goods, and population structures and histories. The Elizabeth site in West Central Illinois is within the Havana Hopewell tradition. This local tradition type is distinct from other iterations of Hopewell in its construction and architecture of earthen mounds, pottery styles, and subsistence-settlement patterns.

Construction of burial mounds during the Middle Woodland period occurred in two main places: bluff crests and floodplains. The bluff crest mounds acted as cemeteries for single habitation sites located at the base of the bluff; whereas, floodplain mound groups occur adjacent to villages situated also in the floodplain. The individuals interred in the floodplain mounds are far less numerous than in the bluff crest mounds, and they are believed to be individuals of multi-community or interregional importance (Buikstra and Charles 1999). With the Late Woodland's increased emphasis on local places and people there is also an increase in the size and the number of individuals interred within each burial mound.

Analysis of material goods in conjunction with biological studies support the model of increased inter-regionality during the Middle Woodland period into an emphasis on the local group during Late Woodland times demonstrated in studies refuting the "Hopewell degeneration" (Buikstra 1976; Buikstra and Charles 1999; Charles 1992; Charles 1995; Conner 1990; Kerber 1983, 1986). In 1995, Neiman examined stylistic changes of Havana ware cooking vessels and applied statistical models from evolutionary biology to model the variations of decorative style through time. Havana ware is the predominate utilitarian ware during the Middle Woodland period that also acts as a counterpart to Hopewell ware, which is almost strictly a ritual ware found in Middle Woodland period burials. According to Neiman, as the Early Woodland period transitioned into the Middle Woodland period, the period consistent with Hopewell, there was a marked increase of stylistic variation likely caused by the expanded trade network. With the dissolution of the interaction network towards the Late Woodland period, there was also a noticeable decline in stylistic variations (Neiman 1995). In conjunction with these findings, Fie (2008) has described through instrumental neutron activation analysis (INNA) that during the Middle Woodland period most of the utilitarian, Havana and Pike wares, vessels are being brought into the region from outside the lower valley. Conversely, most of the ritual vessels such as Hopewell wares that are found almost exclusively in mortuary contexts and are noted for their fine craftsmanship and stylized surface treatments, or geometric and pictorial decorations, are being produced within the lower valley (Fie 2008). Through her INAA analysis, Fie's conclusions also supported previous studies of cranial non-metric biological distances from lower Illinois Valley skeletal remains that there is little support of extended marriage networks outside of a 15 km radius during the Middle Woodland period, which may indicate that the trade network of the Hopewell was primarily based on economic rather than social means—although exchanges of ideas and values most surely occurred as with any meeting of peoples (Bolnick and Smith 2007; Conner 1990; Fie 2008; Konigsberg 1988). Fie's second idea appears consistent with Neiman's (1995) second model that showed as the space between trade partners increases, there is a decrease in stylistic variation in the Havana ware.

Prior to either Neiman (1995) and Fie (2008), Braun had argued through his examination of utilitarian wares across the Woodlands that there was an increase of decorative variation in the wares during the early Middle Woodland period before a marked decline during the late Middle Woodland and into the early Late Woodland period where there was virtually no decoration of utilitarian wares at all. Braun (1991) believed that a major cause of this change in decoration was likely due to changes in social interactions within and between basic social units, which changed from the nuclear family into composite households before transitioning back into the nuclear family as the basic social unit. These changes in social units were likely accompanied with changes in social identities of the group that originally emphasized group difference into an emphasis on group similarity, as is further evidenced by the increased homogeneity of Hopewell symbolism at both village and regional levels (Braun 1991). Braun's ideas appear to be consistent with both Neiman's (1995) and Fie's (2008) arguments. So, while Hopewell practices were extensive, the transaction demonstrated within the region of the lower valley appears to be limited when considering the changes in ceramics appearing throughout the region.

Changes in dietary patterns have also been documented from the Middle to Late Woodland periods. The area of the Illinois River valley is particularly interesting for dietary studies as some of the earliest evidence for the development of maize agriculture in the Eastern Woodlands has been documented (Buikstra and Milner 1992; Rose 2003; Rose 2008). However, the adoption and intensification of maize agriculture, while being an interesting variable to consider in the shift from Middle to Late Woodland periods, should not be overemphasized as a cause for overarching changes in the society, but it offers an interesting problem for the study of a primarily hunter-gatherer group. Considering the environment of the river valley as lushly forested with temperate climate conditions, the region is naturally rich in floral and faunal resources and discussion of these ideas can be found in a number of studies (for examples see Charles 2010; Mueller 2012; Parmalee et al. 1972; Rose 2003; Wiant et al. 2012). The Late Archaic Early, Middle and Early Late Woodland diet consisted of local plants with evidence for husbandry, based upon from botanic remains recovered from sites across the valley that are consistent with the Eastern Agricultural Complex (EAC) (Asch and Asch 1985; Asch and Asch 1986; Asch, Farnsworth, and Asch 1979; Fritz 1990, 2019; Mueller 2012). The finer details of cultivation leading to domestication can be found in Mueller (2012), but an important point is that through the Late Archaic - Woodland periods there is evidence for cultivation leading to domestication—and ultimately to agriculture—of local flora before and during the periods of maize agriculture, gradually and not at the same pace for all cultivars. Evidence from isotopic studies have suggested that dependence on maize agriculture may date to A.D. 400, or the early-Late Woodland period (Buikstra and Milner 1991; Rose 2003; Rose 2008). The findings of more recent maize cupule studies contrast distinctly from early research that emphasize the dependence on maize agriculture being a characteristic of Mississippian period settlement and urbanization with intensification beginning around A.D. 1000 near the end of the Late Woodland period (Vanderwarker, Wilson, and Bardolph 2013). As such, dietary studies of the Woodland period are of continuing interest to current researchers.

Logically after a discussion of the Late Woodland period in Illinois prehistory there is a broad discussion of the Mississippian period with obvious discussion of sites like Cahokia. However, the lower Illinois River valley is different from much of the rest of Illinois in that the presence of the Mississippian culture is relatively minor. Mississippian sites in the valley have been explored in the southeastern edges of the valley closest to the American Bottom region (Goldstein 1980; Farnsworth et al. 1991). Based on archaeological evidence from the valley it is likely that the Late Woodland period overlapped with the American Bottom's Mississippian expression and when the Mississippians began to spread northward in Illinois, they largely bypassed the lower valley for the central valley (Farnsworth et al. 1991). This idea has been somewhat contentious in more recent research (see Delaney-Rivera 2004), but the general model still holds.

Cook and Buikstra (1979) demonstrated in a comparison of dental defects from Middle and Late Woodland populations that the environment of the Late Woodland periods was more stressful for children than in the Middle Woodland period. The authors suggested that this increase in stress could be attributed to a constellation of factors such as population pressure on nutritional resources and weaning diets that relied on carbohydrates with environmental deterioration.  Following this study, Cook (1984) described the changes in health from the Late Woodland to Mississippian periods during the period of food production intensification (beginning as early as A.D. 800) in west central Illinois.  The chapter focused on three significant points: the cost and benefits of intensification on skeletal biology, the validity of data comparisons regarding “health”, and the effects of confounding variables on skeletal data interpretation.  Using data sets of both non-specific stress indicator and paleopathology studies, Cook concluded that the intensification of agriculture in the region lead to worsening childhood health in the late-Late Woodland period and previously unseen density-dependent infectious diseases during the Mississippian period (1984).

**The Elizabeth site.**  In order to describe a model of resilience in prehistoric hunter-gatherer groups, this study will focus on the changes in the population and community from the Elizabeth site, which is a strongly characterized site likely representing a continuous occupation from the Middle to the Late Woodland period.  This model will be tested with lines of data: the first by reframing the Osteological Paradox from the perspective of fragility to resilience, as well as describing changing mortuary practices.  A more thorough description of the methods for this study can be found in Chapter IV.

The Elizabeth site is located on the western blufftop of the Illinois River at the northern end of the valley in Pike County (Figure 2.).

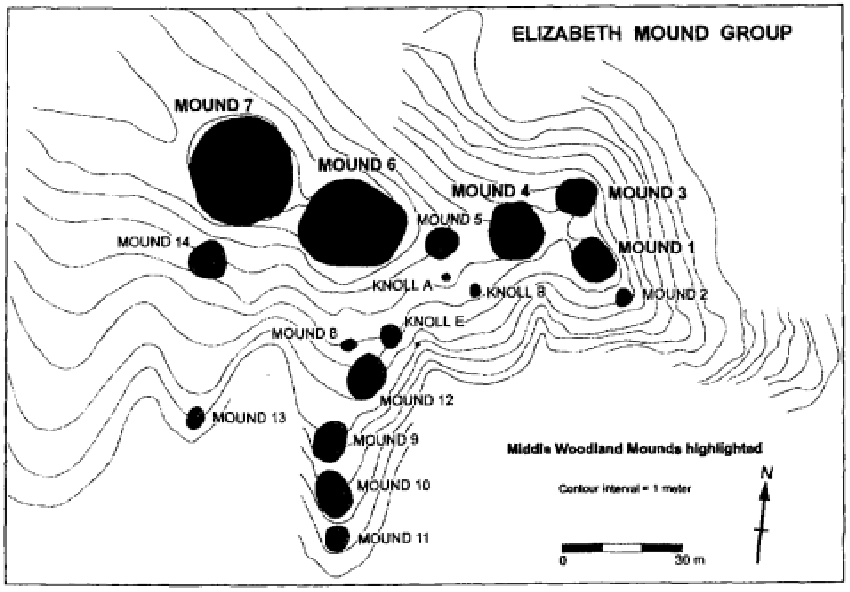


Figure 2. Map of the Elizabeth Site from Buikstra and Charles (1999).

The site was excavated from 1979 to 1985 by the Center for American Archeology (CAA) Contract Program and Northwestern University Archeological Field Schools (NUAFS) for the purpose of land mitigation for the Illinois Department of Transportation FAP 408 Project. From this series of excavations, the Elizabeth site—originally composed of 14 mounds and at least 3 knolls—was found to contain Archaic, as well as Middle and Late Woodland components (Charles et al. 1988). Throughout excavation of the Elizabeth site the primary goal was to collect data in such a way that the formation of the site could best be described as best as possible both physically as well as culturally (Charles et al. 1988). The purpose of this objective was so that more nuanced interpretations and understandings of Woodland sites in the valley could be elucidated (Charles et al. 1988).

Since these excavations, the Elizabeth site has been the focus of several other scientific investigations that have yielded interesting interpretations about the inhabitants, as well as several radiocarbon dates (Charles 1992; Charles et al. 1988; Jones et al. 2017; King et al. 2011; King 2016). Because of the temporal control provided by the radiocarbon dates, as well as the cultural characterizations from past studies, the documentation of the Elizabeth site provides a broad perspective to create models of past lifeways not only for the site but also for the greater lower Illinois River Valley region during the Middle and Late Woodland periods.

With the well documented excavation and excavation methodology, as well as the well-preserved skeletal collection from the Elizabeth site, it has become a model site for geoarchaeological and population studies of the Middle Woodland period in the lower Illinois River valley (Auerbach and Ruff 2010; Buikstra and Charles 1999; Charles 1992, 1995; Charles and Buikstra 2002; Charles et al. 1988; King et al. 2011; Konigsberg 1988; Konigsberg and Frankenberg 2016; Ruby, Carr, and Charles 2005). Radiocarbon dates originating from both carbon and skeletal samples securely place a majority of the site occupation within the Middle Woodland period (50 B.C. – A.D. 400) (see King et al. 2011); however, the Archaic and Late Woodland components of the site have been identified through geomorphological conclusions during the site's excavation, pottery sherds, and cross-site comparisons of mortuary practices (Buikstra and Charles 1999; Charles 1992, 1995; Charles et al. 1988). Individuals and single burials have also provided interesting case studies which have theoretical foundations in the fields of paleopathology and social bioarchaeology (Charles et al. 1988; Cormier and Buikstra 2017; Cormier, Buikstra, and Osterholtz 2017; Jones 2015; Jones et al. 2017). For example, individuals recovered from the Elizabeth site with skeletal dysplasia have offered insights into prehistoric intersectionality of identity and pathology (Charles et al. 1988; Cormier and Buikstra 2017; Cormier, Buikstra, and Osterholtz 2017). Separately, Jones (2015) and Jones et al. (2017) have investigated using isotopic analysis of a burial of six crania from the Elizabeth site to explore and describe biological and social relationships between this burial and others at the site.

In general, mound sites offer a unique perspective for the modelling of past lifeways because the mounds themselves are intentionally built over extensive periods of time and also can be utilized in multiple time periods and in many different ways. The utilization and timing of mounds are difficult to specify without controlled absolute dating methods. However, the intentional and unintentional accretion of mound layers offers a perspective of deep time that can be difficult to document at a site. The problem then becomes that the inherent characteristic of deep time offered by mounds does not always offer adequate fine temporal control. In the case of the Elizabeth site, the deep time offered by the mounds themselves is also enhanced with several radiocarbon dates and material assemblages that allow for relative and absolute dating of site structures.

## III. RESILIENCE, TRANSFORMATION, AND COLLAPSE

As modelled today by archaeologists, resilience was first defined by Holling (1973) as a means to describe the ways in which populations—not specifically human—fluctuate between periods of relative instability and equilibrium. Holling's vision observed changes in population size through time and from there how multiple populations within the same environment could be modelled in a grander ecological system (1973). The homeostasis, or stability, of these large systems relied on the organism populations to adapt to the varying and changing environments around them. In an early example of applying Holling's resilience to human populations, Redman (1999) linearly modelled how a "System State" changed across time in response to degrees of disturbance and consequent degrees of deflection, as well as rates of change (Figure 3).

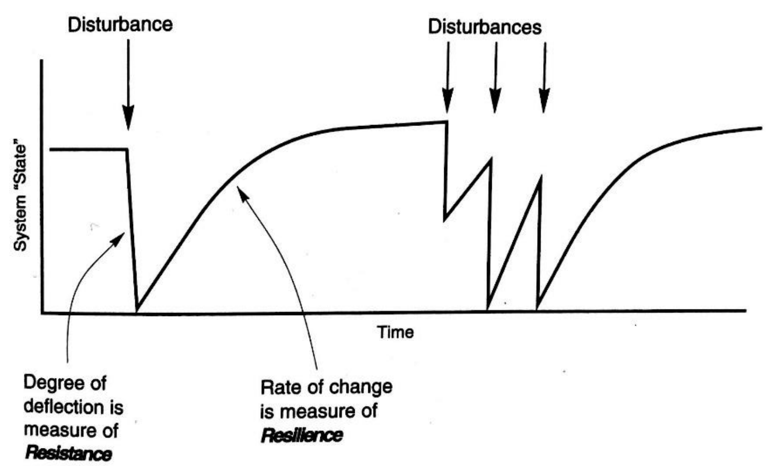


Figure 3. Linear model of changing System States in human ecosystems from Redman (1999).

Traditional ecology theory proposed that three functions—release, exploitation, and conservation—controlled how systems progressed and succeeded one another through time; however, after the idea of resilience was described, a fourth function, reorganization, was defined and all four functions were proposed to be working together in an adaptive cycle (Figure 4) (Redman and Kinzig 2003).

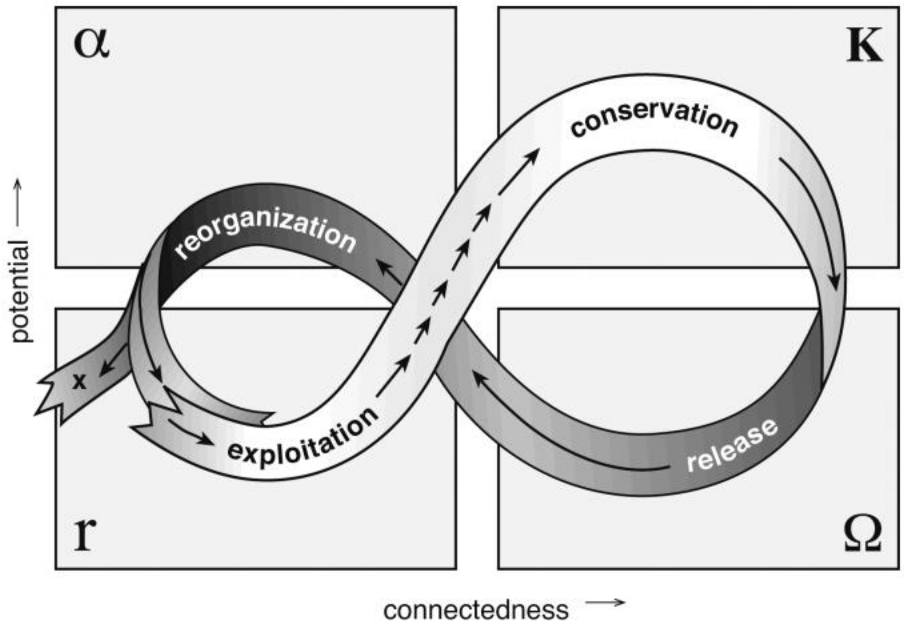


Figure 4. The Adaptive Cycle from Holling and Gunderson (2002).

The adaptive cycle's four phases include release, reorganization, exploitation, and conservation. The release phase represents the increasing fragility and breakdown of a system whose resources are then restructured or transformed into a new system in the reorganization phase. When the new system is established it then undergoes a period of rapid growth, or exploitation, and after being firmly established, growth slows and is consolidated in the conservation phase. The key function that was added by resilience theorists was the reorganization phase, which allowed systems to restructure themselves in order to maintain themselves rather than collapse and be succeeded by a new system (Gunderson and Holling 2002; Redman and Kinzig 2003). The four functions of the cycle flow from one to the next through the natural increases and decreases of biological potential and social connectedness. Potential refers to the natural amount of accumulated biomass available to the system at any given time; whereas, connectedness refers to the strength of the social bonds at any level of the population such as between individuals, or between groups of individuals (Gunderson and Holling 2002). The axes of potential and connectedness act at all scales of the SES and are the measurable variables for modeling resilience for traditional ecological studies. This adaptive cycle is the most basic model for the idea of resilience. However, it is unable to describe relationships between groups in the same way that Holling (1973) initially attempted to describe. In regards to this potential problem, however, Gunderson and Holling (2002) described how the adaptive cycle(s) of systems could interact as a grander network of cycles now referred to as Panarchy.

The Panarchy model (Figure 5.) specifies a nested hierarchy of adaptive cycles to accommodate the effects of time and space upon the interactions of agents within a single system or the combination of multiple systems.

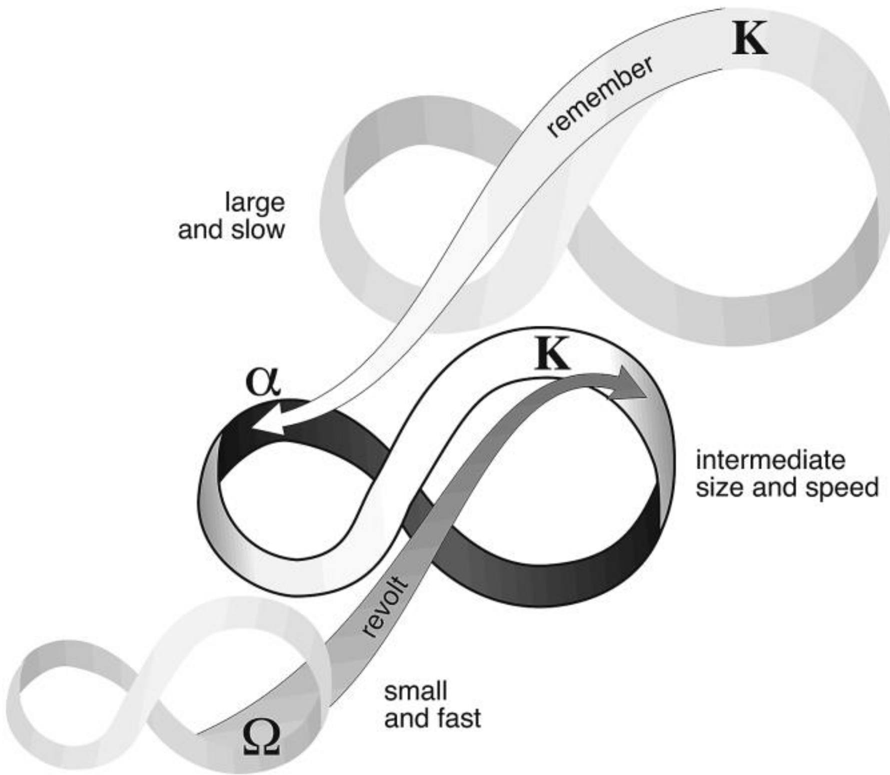


Figure 5. Nested adaptive cycles also known as Panarchy from Holling et al. (2002).

However, the concept of Panarchy thus begins to stretch beyond resilience, which can be described as maintenance of a system through persistence, rigidity, and flexibility, and introduces the potential for transformation. Interactions of the adaptive cycle within the Panarchy are described on scales of time and space and represent concepts of "revolt" (small and fast) and "remember" (large and slow) (Redman 2005). These connections locate the potential for transformation—defined by Walker et al. (2004) as "the capacity to create a fundamentally new system when ecological, economic, or social (including political) conditions make the existing system untenable." According to Walker et al. (2004) then, a transformed society differentiates from a society that is resilient because a resilient group maintains some semblance of its original structure and identity (see also Temple and Stojanowski 2019).

In making the distinction between resilience and transformation, a third population trajectory of socioecological collapse should be further explored. The idea of collapse refers to the rapid decline of complex sociopolitical systems that may, in turn, lead to the total demise of that political system (Faulseit 2016). In short, collapse is a rapid change in political systems from being more to less complex (Conlee 2006). From the connotation of collapse, it is easy to associate the idea with failure. However, as Tainter (2016) aptly points out this association inappropriately describes the multitude of perspectives and facets of a group. Collapse is a completely natural outcome created by a constellation of factors just as resilience and transformation are. This trajectory simply differs in that it represents negative response to variables leading to significant changes among survivors or the complete extinction of a group, but not necessarily its peoples (Butzer 2012; Tainter 1988; Tainter 2016). If collapse was inherently "bad" then who is to say that persistence or transformation are always "good"?

The resiliency construct in human populations is still changing and being refined as more variables are explored and new archaeological and biological data are modelled. Frequently, and quite appropriately, resilience has been discussed in conjunction with transformation and collapse as the difficulty to tease apart interactions of system variables is ever increasing. While the framework for this study will be focused on the question of resilience, it is important to understand that the trajectories of transformation and collapse are also critical to consider especially when observed through a prehistoric context.

The general foundation of resilience theory describes communities and populations as moving through phases of a socioecological system. This system, or cycle, can be thought of as populations moving through periods of stress and disorganization into periods of reorganization, adaptation, and stability. Under this framework synchronic and diachronic time periods can be examined in order to describe community and population changes (Allen et al. 2014; Carpenter et al. 2001; Crane 2010; Faulseit 2016; Hegmon et al. 2008; Holling 1973; Redman 2005; Redman and Kinzig 2003; Temple and Stojanowski 2019; Walker et al. 2004). However, the question remains as to how the suite of socioecological factors can be modeled in human populations along with the material cultures left behind.

Taking relationships between groups/systems into account, Gunderson and Holling (2002) define two different forms of resilience: Engineering and Ecosystem, which were later re-described by Cowgill (2012), as well as McAnany and Yoffee (2010). Engineering resilience is a group's short-term response to preserve homeostasis (Cowgill 2012). Faulseit (2016) renames this type of resilience as political resilience since he believes the particularly charismatic and capable political leaders of a group are more likely to utilize strategies which further legitimize their authority and thereby maintain control. Conversely, Ecosystem resilience is a group's long-term response to adapting to major disruptions of systems and that cannot be resolved quickly (McAnany and Yoffee 2010). This form of resilience was renamed by Faulseit (2016) as Cultural resilience. Faulseit (2016) believes that this form of resilience is most likely displayed by social entities such as clans and moieties. These long-term strategies are possible through the maintenance of old or the creation of new rituals and traditions, which strengthens group identity (Faulseit 2016). For the sake of simplicity these different forms will be discussed in terms of Revolt and Remember cycles that are described within the Panarchy model.

To describe an SES model of resilience in a prehistoric population an analysis of general population health (using non-specific stress indicators as proxies for developmental health and resource availability and changes in disease and occupational load) and mortuary practices across the Middle and Late Woodland periods was defined. Stress, and thereby health, were assessed through frequency of linear enamel hypoplasias (LEHs), frequency and status of periostosis of the tibiae, and average adult stature was examined from the Middle and Late Woodland time periods. A resilient population should show increased frequencies of LEH and periosteal reactions along with an increase in average stature in adults because more individuals should be able to absorb or cope with periods of stress throughout skeletal development and have increased access to resources through an increase in biomass. Mortuary practices were assessed through burial position and other contextual information, such as amount and type of grave goods, including ceramics, associated with individual burials. Changes in body position and buried artifacts were used to describe the changing socio-political and economic realms of these populations.

The Middle Woodland Period of the lower Illinois River Valley is characterized by the valley resettlement, elaborate burial and ceremonial programs, and a broad trade network. Conversely, by the Late Woodland period the valley was more heavily settled, elaborate burials and ceremonialism had declined, and agricultural intensification had begun. Possible indicators of biological resilience through these two periods would be an increase in the frequencies of LEHs and taller, average adult stature from the Middle to Late Woodland periods because of an increase in environmental resource potential. An increase in tibial periosteal reactions (generally) is likely indicative of an increase in disease load, while healed reactions demonstrates the ability to survive through the active pathological process, which could have both biological and social facets to consider. The osteological paradox discusses the idea of poor health in terms of frailty and vulnerability (Cohen, Wood, and Milner 1994; DeWitte and Stojanowski 2015; Wood et al. 1992). With an individual's cause of death not necessarily being known, by looking at proxies for general health, such as non-specific stress indicators, researchers can glean understanding of how individuals and populations were able to cope with disease and wellness. Therefore, the osteological paradox challenges the idea of susceptibility, also known as vulnerability, in which an individual has some sort of baseline resistance or ability to survive acute and/or chronic malignancies. The longer an individual is able to ward off death, then the more likely pathological processes are to develop within the skeletal system. While the osteological paradox is discussed in terms of vulnerability and frailty based on the hidden heterogeneity of people, this idea should be inverted into the idea of biological resilience through the idea of survivorship. Pairing the idea of biological resilience then to the cultural resilience model, the conditions laid out between the Middle and Late Woodland periods may follow the premises laid out by both models in which change is a gradual, drawn out process in the face of chronic stress, and would demonstrate that the people of the Middle and subsequent Late Woodland periods were resilient. Population growth and changing socio-economic trends following into the Late Woodland population from the Middle Woodland population at the Elizabeth site demonstrates a shift biological potential and social connectedness broadly. For example, Cook and Buikstra (1979) and Cook (1984) previously inferred an increased level of malnutrition in Woodland populations based upon increases in LEH frequency in Late Woodland times at other sites in the lower Illinois River Valley. The discussions of LEH frequency (as one example) were broad and attempted to demonstrate the variable's utility when contextualized in providing more meaningful explanations of past lifeways.

If the Late Woodland period represents a shift into the exploitation phase for example, then the elaborate burial practices and ceramics found in the preceding Middle Woodland period may be evidence of an attempt by religious or political leaders to consolidate their authority by creating a structured burial program. Fie (2008) claimed that Hopewell ware pottery, which is ceremonial and primarily found in burials, was being produced within the Lower Illinois Valley. So, if the Middle Woodland period is a time of reorganization and developing structures, then throughout the Middle Woodland period the pottery found in burials should become less variable in vessel form (i.e. bowl and jar shape) because the enforced structures would re-enforce ideals of authority. However, decoration of pottery, such as engraved or incised lines, may become more variable and/or stylized in response to this decline in vessel form variation.

Like pottery, the burial practices of the Middle Woodland period may also be more formalized in terms of individuals of high status being buried, as well as specific body position and locations, but that may have led to increased variation or stylization of grave goods. With the decline of the Hopewell phenomenon at the end of the Middle Woodland period and the transition to the Late Woodland period, the burial structures imposed during the Middle Woodland period would increase in variation because there are fewer formal, imposed structures. Burial positions and styles, as well as the individuals included within the burial program would become more diverse. Pottery within the burials would have also been affected by the decline of Hopewell, so the pottery within the burials would show more variability in form while decorations show less or even no variation or stylization.

The Adaptive Cycle as applied through an ecological framework provides a lens for considering the ebbs and flows of biological potential and organismic connectedness across time and space. Applying this model to a human population's environmental and populational biological potential and social connectedness is also possible. However, a prehistoric population is difficult to examine through the Adaptive Cycle and consequently the Panarchy Model because of the degree of uncertainty inherent to archaeological data and inferences. In order to explore the idea of resilience, the population at the Elizabeth site was considered because of its documented chronology in the lower Illinois River Valley as a contiguous population across cultural periods.

It is hypothesized that the shift from the Middle to the Late Woodland period represents a period of increasing biological potential because of the documented population growth within and between periods. The changes in the socio-political and economic realms of society, such as changes in ceramic styles (both technic and decorative style) and burial architecture indicated changes in social connectedness. If both biological potential and social connectedness are increasing from the Middle Woodland to the Late Woodland periods, then the population is moving along the Adaptive Cycle from the exploitation to conservation phase. Associated changes to the proposed variables would be a marked increase in LEH frequency because of the increase in available nutritional resources, an overall increase in achieved stature because of the available resources, and an increase in tibial periostosis because of the increase in population size. Changes to socio-political and economic practices would be reflected in burial practices due to changing social roles of individuals and groups within the population. "Measuring" connectedness requires broad contextualization, but should be reflected by meaningful patterns of consistent or changing burial practices between time periods. When placing the Middle and Late Woodland periods in a broader time scale, it is likely that change from exploitation to conservation is likely due to the absence of the Early Woodland populations in the LIV.

# IV. MORTUARY THEORY OF ARCHAEOLOGICAL DATA SETS

Modern mortuary theory has its roots in the early years of the New Archaeology movement with rapid development beginning in 1970 and 1971 after publications by Saxe (1970), Binford (1971), and Brown (1971). These Processual publications by Saxe and Binford in particular, and with the platform provided by the publication of Brown's symposium, have led to a rich theoretical framework for modern archaeologists. In their works, Saxe and Binford tested whether social relations and complexity could be described using archaeological mortuary data and tested their respective hypotheses utilizing ethnographically derived data. In order to describe social relations and social complexity of a prehistoric group, the Saxe-Binford model attempts to model a person's identity based on the characteristics of what Brown (1981) would call social rank, power, and authority. These three characteristics were generalized by Brown under the term rank, and he argued that mortuary data could be used in three main models to understand social relationships: the effort-expenditure principle, understanding symbols of authority, or describing the demographic structure (1981). These three models, Brown argued, could be utilized independently or in conjunction with one another. Each model operates from a different perspective (economic in the effort-expenditure principle, symbology, and cemetery population structure) that adds flexibility to mortuary study interpretations, especially when used in conjunction with one another to detect meaningful patterns.

By identifying the variations in mortuary treatment of the individuals and then comparing these individuals to one another, meaningful patterns and relationships should be identifiable. In Saxe and Binford's model, there assumes that there is a power or corporate structure of some sort in place. This assumption is in part due to the nature of their original hypothesis testing in which ethnographic evidence was used as proxy for defining structures and relationships that were assumed analogous to the past (Charles 1995). However, Charles and Buikstra (1983) used the ideas originally outlined by Saxe and Binford, and which had been elaborated upon by others such as Goldstein (1976), and developed a methodology using mortuary data from Archaic period sites in the central Mississippi River drainage that analyzed the mortuary domain's spatial structure to corporate activities. By looking at the Archaic groups' subsistence-settlement patterns, demographic characteristics, and economic activities, Charles and Buikstra were able to successfully argue a nuanced interpretation of Archaic social life using strictly archaeological data from a non-sedentary perspective. Their arguments thus demonstrated that it is possible to apply archaeological mortuary data to understand the broader social fabric of groups.

The Saxe-Binford paradigm was not established without critique, however, as countering arguments were quickly developed. The greatest critique of Saxe and Binford's model came during the Post-Processual movement and was initially voiced by Hodder (1980) and Pader (1980). The Post-Processual critique argues that the Processual approach to understanding mortuary practices is overly simplistic. As the scale and complexity of the society increases, so does the number of ideological pathways available to mask social relations according to desires of those in power (Hodder 1980). By extension, Pader (1980, 1982) extended Marxist arguments to the argument that symbols, an extension of ideology, are constantly re-created in a society, and these recreations are constructed not only by the structurally established order, but also potentially in a way that misrepresents reality. While the arguments made against the Processual model have yet to be fully supported there is a single critique that should be kept in mind when evaluating mortuary data in large, complex societies: mortuary ritual is one of many possible ways to symbolize social relationships (Charles 1995).

In addition to the Processual and Post-Processual perspectives there are various subsequent interpretive approaches to understanding mortuary behaviors, and which have been the perspective most commonly used in recent scholarship of the LIV (Buikstra and Charles 1999; Buikstra et al. 1998; Charles 2010, 2012; Charles and Buikstra 2002; Hall 1980, 1995). From interpretive perspectives the full context and uniqueness of the society or culture should be taken into account when forming explanations. It is from this type of approach from which the interpretation of mound-building as a world renewal event has been constructed (Hall 1997).

In a pivotal piece of work from 1989 and of considerable interest for this current study, Cannon demonstrated through several case studies ranging from classical to historic times that mortuary behaviors act in a cyclical nature according to changes in social structures (including but not limited to politics, religion, and economics), or changes to cultural ideologies. The ideas proposed by Cannon added significantly to the growing body of mortuary theory that conceptualized archaeological mortuary program complexity as a proxy for social structures (Saxe 1970; Binford 1971; Brown 1971, 1981; Buikstra 1976; Goldstein 1980; Kerber 1983). While Cannon's work focused on changes in material culture through time and the specific power relations that various symbols imply, an important point that his study brings to light is that memory is appropriated and politicized. In other words, memory and the actions of those working through or within it (i.e. the living *and* the dead) hold power that underlie all sociocultural structures, and thereby stresses the importance of memory enacted through mortuary rites.  However, what Cannon does not offer is a way to specify underlying structures when groups do not have a written history.  He claims that "Archaeologists and anthropologists must recognize in mortuary change the operation of these historical processes, which apply beyond particular social and cultural circumstances," (Cannon 1989: 447).  In order to get around this problem, I have chosen to interact with the only "survivors" of a group without a classically documented history—the dead.

## V. MATERIALS AND METHODS

The skeletal population used in this study consisted of individuals from a majority of the mounds at the Elizabeth site. These individuals are dated from the Middle Woodland (50 B.C. – A.D. 400) and the Late Woodland (A.D. 400 – 1000) time periods (Figure 6).

| Site / Period | Context | Lab Sample[1,2,3] | $^{14}$C Age±E | 95.4% Distribution | | Median |
|---|---|---|---|---|---|---|
| Elizabeth MW | EZ 6 Feature 1 Prep Surface | ISGS-844 | 2070±75 | -356 | 77 | -97 |
| | EZ 7 Feature | ISGS-1316 | 2030±70 | -339 | 126 | -46 |
| | EZ 4-2 | QL-4893 | 2010±15 | -47 | 47 | -13 |
| | EZ 1-3-1 | QL-4891 | 1990±15 | -40 | 55 | 13 |
| | EZ 6 Feature 1- Central Tomb | ISGS-1140 | 1980±70 | -173 | 210 | 14 |
| | EZ 7-9-2 | QL-4895 | 1940±16 | 21 | 122 | 63 |
| | EZ 7 Central Tomb | ISGS-1317 | 1940±70 | -111 | 240 | 62 |
| | EZ 6-4-5 | QL-4894 | 1908±15 | 63 | 129 | 97 |
| | EZ 3-2-1 | QL-4892 | 1881±16 | 72 | 210 | 111 |
| | EZ 3-7-1 | GX-18529-AMS | 1767±51 | 133 | 384 | 269 |
| Elizabeth LW | EZ 10-14 | QL-4896 | 1312±21 | 659 | 766 | 687 |
| | EZ 10-14b | ISGS-1527b | 1260±70 | 648 | 947 | 761 |
| | EZ 10-14a | ISGS-1527a | 900±100 | 904 | 1284 | 1126 |

Figure 6. Elizabeth Mounds radiocarbon dates from King (2016).

Examining these time periods allowed for an analysis of changing traditions and through these cultural changes, the biological responses to these changes as it was assumed that residents of the Late Woodland phase were descended from those of the Middle Woodland phase. Meaningful results in paleodemographic studies require a large sample size. From these two time periods, 94 adult individuals (Middle Woodland n=52, Late Woodland n=42) from the collections of the Center for American Archeology, housed at the Illinois State Museum in Springfield, Illinois were analyzed for skeletal pathologies. Another 18 non-adult individuals were separately examined as they had associated grave goods. Generally, all individuals were well preserved but missing and degraded individual elements were common.

Several limitations to this study should be mentioned, the most pressing at the time of the project's proposal was that Resilience Theory had not been applied to many biological anthropology studies and as such, a biological model had not been established (DeWitte et al. 2016; Hoover and Hudson 2016). During data collection for this study Temple and Stojanowski (2019) was published and alleviated this limitation before data analysis. There was also a major factor of time concerning the collection of data. As time was limited, a holistic (that is to say all biological, ecological, and social analyses) study of multiple communities could not be completed. However, a major goal of this study was to begin the development of a biological model that could be applied to studying archaeological populations and communities. Because of this goal, the limitations briefly mentioned were minimized for the current study as the results of this study may inspire future studies in the lower Illinois River valley.

**Linear enamel hypoplasia.** Linear enamel hypoplasias (LEHs, also called DEH) are a non-specific stress marker found on teeth, which are created during the development of the teeth and are visible to the naked eye or under weak magnification. Since LEHs form in the enamel and because enamel forms in a predictable pattern, the measurement of LEHs can indicate specific periods of time when the individual was stressed before fully maturing. Stress is caused by external or internal forces such as environmental factors, insufficient resource access, or disease (Hillson 2005, 2014). There have been several methods proposed in order to observe and collect LEH data that range from the simple recording of presence or absence—the method used in this study—to the measurement of the exact location of the appearance of LEH bands on the teeth with calipers. In a broad paleodemographic/paleoepidemiological study such as this one that is examining a constellation of non-specific stress indicators, and is broadly framed in deep time, the mere presence/absence approach was chosen to save time and because the data for a population such as this archaeological one would not offer any other greater interpretation for the model being tested. The most dependable teeth to observe for LEH are the incisors and the canines because their development is correlated closely and more stable than the premolars or molars (Hillson 2005). LEHs are a useful proxy when attempting to correlate community health to community resilience because they are non-specific stress indicators that can be directly correlated to age (DeWitte 2016; Hoover and Hudson 2016; Wilson 2014; Wood et al. 1992). Observations of both mandibular and maxillary incisors and canines was undertaken to maximize the number of teeth possibly observable from the archaeological context.

**Stature.** In 2010, Auerbach and Ruff developed regression formulae for living stature estimation of Native American populations using the revised Fully Anatomical Technique. These formulae are significant because the samples utilized to develop them were taken from archaeological contexts from around the North American continent. Multiple formulae with calculated standard deviations were derived and correspond to specific cultural areas throughout North America. Populations from the Illinois River Valley were found to be most similar to other groups from the Great Plains region rather than the Eastern Woodland or Prairie groups as would be expected based on cultural similarities (Auerbach and Ruff 2010). As such, when calculating achieved stature for individuals from the Elizabeth site, the Great Plains functions were utilized. Before measurements were taken of the lower limb, sex estimation was confirmed from Charles et al. (1988) through inspection of morphological traits of the bony pelvis and skull. This author was in full agreement with previously published biological sex estimations. The method for calculating stature required the measurement of the femoral bicondylar length (FBL, Martin, 1928, #1) and tibial maximum length (TML, Martin, 1928, #1a) using an osteometric board. Measurements of the skeletal elements were taken from the left side when possible. Auerbach and Ruff (2010) utilized the standards of measurement for these two measurements from Raxter et al. (2006). There are three regression formulae that can be performed to estimate living stature according to Auerbach and Ruff's methodology. Two of these formulae utilize only FBL or TML, while the third formula incorporates both measurements. It is this third formula that has been shown to be the most accurate of the three, and as such was given priority when both measurements were taken for an individual. After measurements were taken, they were then applied to the appropriate regression formulae based on biological sex and cultural area from which the prehistoric population is best aligned. In the case of the Elizabeth site, the Great Plains formulae were the best fit based on its geographic location within the modern state of Illinois (Auerbach and Ruff 2010).

**Periostosis**. Periostosis can be a result of any number of causes such as developmental disorders, inflammatory diseases, trauma, and tumors (Buikstra et al. 2017). Because of the multitude of possible causes, periostosis is called a non-specific stress marker and is commonly found on the tibiae due to their close location to the outer skin surface. As a pathological process, description of the bony changes at the time of death can be assessed in order to consider the health status of an individual (DeWitte

2014; Pinhasi and Mays 2008; Weston 2008). Active periosteal remodeling has the appearance of unintegrated woven bone, while healed periosteal remodeling appears as integrated woven, or sclerotic bone. The periosteal remodeling process can also have a mixed appearance of woven and sclerotic bone that would indicate that the periostosis is actively healing rather than actively remodeling (Pinhasi and Mays 2008). Observations of the tibiae were recorded and described whether there is or is not any periostosis in order to understand the frequency of periostosis within different demographic segments of the population. The different statuses of the irregular periosteal growth (active, healing, or healed) were also recorded in an attempt to discuss the potential changes to the different demographic segments through time similarly to DeWitte (2014).

**Burial and Mortuary Practices.** Records and descriptions of the various burial practices within the region have been continuously documented since their excavations. The most extensive descriptions of the burials come from the excavations of Gregory Perino whose work in the region began in 1950, as well as those excavations run through the now named Center for American Archeology (CAA). These two parties excavated and then helped to preserve the remaining mound groups throughout the lower valley. Through their work, they have detailed the various burial and mortuary practices such as burial location and body positions within the mounds, and recorded the grave goods associated with the buried individuals (Buikstra 1976; Charles et al. 1988; see especially Perino et al. 2006: 125-136). While more recent works and interpretations are regularly being made about individual burials or mound groups, a broad regional examination of burial practices, in conjunction with analyzing specific facets of health and material culture will bring to light broader patterns of the regional lifeways. As such, the present study examined previously published and unpublished records of primary burial practices such as burial context, including location within the burial mound and body position, as well as proximity between individuals, and presence of grave goods (i.e. pottery, body adornments, various projectile points, and faunal materials) in order to identify meaningful patterns and trends throughout the region within and between the Middle and Late Woodland periods at the Elizabeth site.

**Data Sample and Analysis.** Data collected for this study consisted of frequency of linear enamel hypoplasia (LEH) on the maxillary and mandibular incisors and canines, frequency and status of periostosis of the tibiae, average stature calculated from the regression formulae in Auerbach and Ruff (2010) that incorporated FBL and TML between the mounds, as well as basic burial and mortuary reconstructions. These newly collected data were utilized along with descriptions previously published of burial contexts in order to better characterize the underlying trends within the temporal and cultural periods being studied. Pathological data was collected from all Middle and Late Woodland adult individuals when possible (n=94).

Both parametric and non-parametric statistical analyses were utilized to test whether there was a significant difference between the data sets of the two time periods. As such, the nominal LEH and periostosis data were tested using Chi-square analyses, while the ratio stature estimates were tested using an analysis of variance (ANOVA) test. Burial posture analysis was also tested for any significant patterning using a Chi-square test. Other forms of burial mortuary analysis relied on qualitative analysis. The analyses outlined here remained in their simplest form in order to test for the model of resilience, and any significant patterns (discussed in later chapters) can be later tested with more sophisticated analyses.

# VI. RESULTS

A total of 94 adult individuals were observed from both the Middle and Late Woodland periods from the Elizabeth Mounds site. The Middle Woodland sample contained 27 female and 25 male individuals for a total of 52 individuals. The Late Woodland sample consisted of 22 female individuals and 20 male individuals for a total of 42 adult individuals. In addition, 63 non-adults were included for study in the analysis of grave goods. All collected data can be found in Appendices A and B for future research considerations.

**Age and Sex.** Biological sex estimations were made using morphological features from both the pelves and skulls of the adult individuals (Charles et al. 1988). Age-at-death estimations utilized methods of endocranial suture closure and pubic symphyseal face changes, and they were also calculated for publication in Charles et al. (1988). There is no significant difference between the two time periods based on biological sex alone. However, there are significantly more “Young Adult” (ages 20-35 years) individuals in the Late Woodland sample than in the Middle Woodland sample ($p = 0.001$). Conversely, there are significantly more “Old Adult” (ages 50+ years) individuals in the Middle Woodland sample than there are in the Late Woodland period (Table 2.).

**Table 2. Comparison of adult age cohorts by temporal component showing a significant difference in the number of Young and Old Adults between time periods.**

| Age Category (Count/Observed, %) | | | |
|---|---|---|---|
| **Component** | **Young Adult** | **Middle Adult** | **Old Adult** |
| **MW** | 10/52, 19.2% | 17/52, 32.7% | 25/52, 48.1% |
| **LW** | 22/42, 52.4% | 10/42, 23.8% | 10/42, 23.8% |
| **Fisher Exact Pairs** | 0.0010* | 0.3695 | 0.0190* |

When examined more closely via a Fisher's Exact Test, the shift in the age demographics is from a changing female population. While there is no significant change in the number of females included in burials from the Middle to Late Woodland periods, during the Late Woodland period there is an increase in the number of Young Adult females and a decrease in the number of Old Adult females with no change to the "Middle Adult" (ages 35-50 years) female cohorts (see Table 3.).

**Table 3. Comparison of adult female age cohorts by temporal component showing a significant difference in the number of Young and Old Adults between time periods.**

| Age Categories of Females (Count/Observed, %) | | | |
|---|---|---|---|
| **Component** | **Young Adult** | **Middle Adult** | **Old Adult** |
| **MW** | 2/27, 7.4% | 9/27, 33.3% | 16/27, 59.3% |
| **LW** | 12/22, 54.5% | 4/22, 18.2% | 6/22, 27.3% |
| **Fisher Exact Pairs** | 0.0004* | 0.3328 | 0.0426* |

Conversely, there are no significant changes in the male age cohorts from the Middle to Late Woodland periods (Table 4.). Between the two time periods, male individuals of all age cohorts were similarly represented, serving to highlight the significant differences in the female segments of the population.

**Table 4. Comparison of adult male age cohorts by temporal component showing no significant difference in the distribution of individuals per age cohort.**

| Age Categories of Males (Count/Observed, %) | | | |
|---|---|---|---|
| **Component** | **Young Adult** | **Middle Adult** | **Old Adult** |
| **MW** | 8/25, 32.0% | 8/25, 32.0% | 9/25, 36.0% |
| **LW** | 10/20, 50.0% | 6/20, 30.0% | 4/20, 20.0% |
| **Fisher Exact Pairs** | 0.2412 | 1.000 | 0.3271 |

Table 5 is a comparison of the distribution of adult age categories on the basis of biological sex within each temporal component, and illustrates the change in representation of each age cohort on the basis of biological sex.

**Table 5. Comparison of adult age cohorts within temporal components on the basis of biological sex.**

| Age Category (Count/Observed, %) | | | | | | |
|---|---|---|---|---|---|---|
| **Biological Sex** | **MW Young Adult** | **MW Middle Adult** | **MW Old Adult** | **LW Young Adult** | **LW Middle Adult** | **LW Old Adult** |
| **F** | 2/27, 7.4% | 9/27, 33.3% | 16/27, 59.3% | 12/22, 54.5% | 4/22, 18.2% | 6/22, 27.3% |
| **M** | 8/25, 32.0% | 8/25, 32.0% | 9/25, 36.0% | 10/20, 50.0% | 6/20, 30.0% | 4/20, 20.0% |
| **Fisher Exact Pairs** | 0.0356* | 1.0000 | 0.1066 | 1.0000 | 0.4769 | 0.7225 |

In the table above, it can be seen that in the Middle Woodland period, there is a significant difference in the number of young adult females in comparison to males at the 0.05 level, but not in the other age categories. However, by the Late Woodland period the number of young adult females increased to be similarly represented as the male sex and no further changes in demographics occurred between the two time periods.

**Linear enamel hypoplasia analysis.** Comparisons of the frequency of linear enamel hypoplasia (LEHs) were performed using Chi-square and Fisher's Exact statistical tests. Table 6 illustrates that there is significantly more ($\chi^2$ p = 0.0355) LEH occurrence in the Late Woodland sample than in the Middle Woodland sample (Fisher Exact p = 0.0325).

**Table 6. Comparison of the frequency of Linear Enamel Hypoplasias (LEH) between temporal periods (affected/total, %).**

| Component | Absent | Present |
|---|---|---|
| **MW** | 17/44, 38.64% | 27/44, 61.36% |
| **LW** | 7/39, 17.95% | 32/39, 82.05% |
| **$X^2$** | 0.0355* | |
| **Fisher Exact Pairs** | 0.0325* | |

A comparison of the frequency of LEH by biological sex within each temporal period (Table 7.), and between each temporal period (Table 8.) demonstrates that there is no significant difference in the number of individuals affected.

**Table 7. Comparison of the frequency of Linear Enamel Hypoplasias (LEH) within temporal periods by biological sex (affected/total, %).**

| | **Temporal Component** | | | |
|---|---|---|---|---|
| | **MW** | | **LW** | |
| **Biological Sex** | **Absent** | **Present** | **Absent** | **Present** |
| **F** | 10/22, 45.45% | 12/22, 54.55% | 5/21, 23.81% | 16/21, 76.19% |
| **M** | 7/22, 31.82% | 15/22, 68.18% | 2/18, 11.11% | 16/18, 88.89% |
| **$X^2$** | 0.3520 | | 0.2949 | |
| **Fisher Exact 2-Tail** | 0.5365 | | 0.4179 | |

**Table 8. Comparison of the frequency of Linear Enamel Hypoplasias (LEH) between temporal periods by biological sex (affected/total, %).**

| | **Biological Sex** | | | |
|---|---|---|---|---|
| | **F** | | **M** | |
| **Component** | **Absent** | **Present** | **Absent** | **Present** |
| **MW** | 10/22, 45.45% | 12/22, 54.55% | 7/22, 31.82% | 15/22, 68.18% |
| **LW** | 5/21, 23.81% | 16/21, 76.19% | 2/18, 11.11% | 16/18, 88.89% |
| **$X^2$** | 0.1337 | | 0.1087 | |
| **Fisher Exact 2-Tail** | 0.2027 | | 0.1489 | |

Following the comparison within and between temporal periods of biological sex affected by LEH, a similar comparison was carried out by age cohorts between time periods. For this analysis, all individuals were pooled in each cohort due to limited sample size. A comparison of the frequency of LEH in age cohorts by biological sex would be of interest in future studies with larger sample sizes. Table 9, below, shows the comparison of LEH frequency between temporal periods by each adult age cohort, and demonstrates that there are no significant differences in the frequency for any cohort between the Middle and the Late Woodland.

**Table 9. Comparison of LEH frequency in adult age cohorts between temporal components.**

| **Age Category (Affected/Observed, %)** | | | | | | |
|---|---|---|---|---|---|---|
| **Component** | **Young Adult Absent** | **Young Adult Present** | **Middle Adult Absent** | **Middle Adult Present** | **Old Adult Absent** | **Old Adult Present** |
| **MW** | 1/9, 11.11% | 8/9, 88.89% | 6/15, 40.00% | 9/15, 60.00% | 10/20, 50.00% | 10/20, 50.00% |
| **LW** | 3/22, 13.64% | 19/22, 86.36% | 2/8, 25.00% | 6/8, 75.00% | 2/9, 22.22% | 7/9, 77.78% |
| **$X^2$** | 0.8471 | | 0.4656 | | 0.1497 | |
| **Fisher Exact 2-Tail** | 1.0000 | | 0.6570 | | 0.2341 | |

**Periostosis of the tibiae.** Chi-square statistical tests were utilized to analyze the frequency of periostosis occurrence on the tibiae. As Table 10 shows, the occurrence of periostosis (at any stage of the pathological process) was significantly greater in the Middle Woodland than in the Late Woodland period.

**Table 10. Comparison of tibial periostosis frequency between temporal periods (affected/total, %).**

| Component | Absent | Present |
|---|---|---|
| **MW** | 17/44, 38.64% | 27/44, 61.36% |
| **LW** | 28/40, 70.00% | 12/40, 30.00% |
| **$X^2$** | 0.0037* | |
| **Fisher Exact 2-Tail** | 0.0048* | |

The Fisher Exact test also indicated that there is a greater probability of tibial periostosis present in the Middle Woodland period than in the Late Woodland period ($p = 0.0037$). Within each time period, there is no significant difference in the occurrence of periostosis by sex; however, this is not the case between time periods. Table 11 shows that there is significantly more periostosis in the female population of the Middle Woodland period than during Late Woodland times, while there is also a significant difference in the male population between periods.

**Table 11. Comparison of tibial periostosis frequency between temporal periods by biological sex (affected/total, %).**

| | Biological Sex | | | |
|---|---|---|---|---|
| | F | | M | |
| **Component** | **Absent** | **Present** | **Absent** | **Present** |
| **MW** | 8/26, 30.77% | 18/26, 69.23% | 9/18, 50.00% | 9/18, 50.00% |
| **LW** | 12/20, 60.00% | 8/20, 40.00% | 16/20, 80.00% | 4/20, 20.00% |
| **$X^2$** | 0.0464* | | 0.0496* | |
| **Fisher Exact 2-Tail** | 0.0726 | | 0.0869 | |

The significance between the female samples is barely significant with a p-value of 0.0464, while the significant result between the male samples is also barely significant with a calculated p-value of 0.0496. Because both of these results were borderline significant at the 0.05 level, Fisher's Exact Tests were performed to better characterize these results. The Fisher's Exact Test for females between cultural periods still found a significantly higher frequency of periostosis in the Middle Woodland than in the Late Woodland (p=0.0460). The Fisher's Exact Test for periostosis presence in the male population between cultural periods, however, was not significant. Future considerations of these results will prioritize the findings of the Fisher's Exact Test rather than the generalized chi-square analyses.

Analyses for periostosis occurrence also examined patterns within and between adult age cohorts. Within the Middle and Late Woodland periods, there were no significant differences in periostosis frequency by age cohorts. Between the Middle and Late Woodland periods, however, there was a significantly higher frequency of periostosis in the Middle Woodland period than the Late Woodland period for the Older Adult cohort (Table 12.).

**Table 12. Comparison of tibial periostosis frequency in adult age cohorts between temporal components.**

| Age Category (Affected/Observed, %) | | | | | | |
|---|---|---|---|---|---|---|
| **Component** | **Young Adult Absent** | **Young Adult Present** | **Middle Adult Absent** | **Middle Adult Present** | **Old Adult Absent** | **Old Adult Present** |
| **MW** | 3/6, 50.00% | 3/6, 50.00% | 6/14, 42.86% | 8/14, 57.14% | 8/24, 33.33% | 16/24, 66.67% |
| **LW** | 13/21, 61.90% | 8/21, 38.10% | 7/9, 77.78% | 2/9, 22.22% | 8/10, 80.00% | 2/10, 20.00% |
| **$X^2$** | 0.6029 | | 0.0922 | | 0.0111* | |
| **Fisher Exact 2-Tail** | 0.6618 | | 0.1968 | | 0.0229* | |

For all analyses of periostosis frequency, comparisons of the pathological statuses (i.e. active, healing, and healed) were also made, however, there were no significant patterns identified. As a general trend, however, when periostosis was observed it was either healing or healed. In only a single instance was active periosteal reaction recognized in this sample.

**Analysis of stature.** Stature estimates were made using the regression formulae developed by Auerbach and Ruff (2010) and can be found in Appendix A along with all other biological observations. The stature estimate for each adult individual in the study sample was made using the most accurate formula depending on the preservation of the long bones of the leg. Formula 3 was primarily privileged over Formula 1 and before Formula 2. In order for Formula 3 to be used, both the femur and tibia of the same side had to be present and in good enough condition for measurements to be made, and when both left and right pairs were present for a single individual the left side was used to calculate the individual's stature.

Stature was estimated for 36 females, while 12 individuals could not be measured using Auerbach and Ruff's (2010) method. One individual (EZ 3-7-1) was excluded from the Analysis of Variance (ANOVA) test because of the individual's pathological condition. The estimated range of female stature in the Middle Woodland period is 150.626-170.112 cm., and in the Late Woodland Period is 147.924-169.336 cm. The mean stature calculated by the Shapiro-Wilk W test for females is 158.692 centimeters. Stature was also estimated for 29 males, and 16 individuals could not be measured using Auerbach and Ruff's (2010) method. Male stature in the Middle Woodland period is estimated to be between 157.914 and 182.058 cm., while in the Late Woodland Period is between 153.342 and 178.376 cms. The mean stature of males calculated by the Shapiro-Wilk W test was 167.058 cm.

After calculating each individual's estimated stature at time-of-death, the median measures were compiled by biological sex for an ANOVA test. Both female and male samples were found to be normally distributed via Shapiro-Wilk W tests. The ANOVA tests found no significant differences in the average statures for either females or males between the Middle and Late Woodland periods (Female $p = 0.5864$; Male $p = 0.8401$).

**Burial postures.** The manipulation of the deceased body is one of the most fundamental facets of studying mortuary behaviors. At this most basic level, in order to better reveal patterns of behavior within the context of the Elizabeth site, descriptive statistical analysis of demographic characteristics in relation to body posture were carried out much like the biological analyses previously presented. Detailed descriptions of each burial and the individuals within them can be found in Charles et al. (1988: Appendix 2). Careful consideration of these burial descriptions revealed two major burial postures in


the Middle and Late Woodland periods: extended (n = 52) and flexed (n = 30) (Figure 7.).

Figure 7. Elizabeth Mounds Mound 1 Burials 33 and 15 illustrating the two main burial postures of the Middle and Late Woodland periods: extended and flexed (Left and Right respectively) (Photos courtesy of the Illinois State Museum).

Individuals buried in an extended posture were generally complete skeletons, the bones of which were preserved in anatomical position. The skeletons that remained of those in a flexed posture were also relatively complete skeletons, but rather than lying flat, the appendicular skeleton (arms and legs) had been placed in a flexed position leaving the individual in a fetal position. In the Middle Woodland period, extended burials (extended on back, front, or side) made up a majority of the burials; whereas in the Late Woodland period a majority of individuals were buried in a flexed position (Table 13).

**Table 13. Comparison of burial postures between temporal periods (count/total, %).**

| Component | Extended | Flexed |
|---|---|---|
| **MW** | 39/44, 88.64% | 5/44, 11.36% |
| **LW** | 13/38, 34.21% | 25/38, 65.79% |
| **$X^2$** | < 0.0001* | |
| **Fisher Exact 2-Tail** | < 0.0001* | |

The difference between the two time periods is statistically significant with the probability of an individual being buried in a flexed position during the Late Woodland period becoming the major trend between the two time periods according to a Fisher's Exact test (p = < 0.0001).

Statistical tests within each temporal period on the basis of biological sex revealed a significant trend. In the Middle Woodland period, there was found to be no significantly different treatment in body posture between females and males, and the overall trend was to bury any adult in an extended position (see Table 14).

**Table 14. Comparison of Middle Woodland burial postures by biological sex (count/total, %).**

| Biological Sex | Extended | Flexed |
|---|---|---|
| **F** | 25/26, 96.15% | 1/26, 3.85% |
| **M** | 14/18, 77.78% | 4/18, 22.22% |
| **$X^2$** | 0.0574 | |
| **Fisher Exact 2-Tail** | 0.1417 | |

However, a test of body posture in the Late Woodland period based on biological sex demonstrates a strongly significant change ($\chi^2$ p = <0.0001) from the Middle Woodland period in the positioning of females and not for males.  The pattern change, from predominantly extended burials to flexed burials, from the Middle to Late Woodland periods appears to primarily be a change brought about by female posture primarily being flexed in the Late Woodland period (see Table 15).

**Table 15. Comparison of Late Woodland burial postures by biological sex (count/total, %).**

| Biological Sex | Extended | Flexed |
|---|---|---|
| **F** | 1/20, 5.00% | 19/20, 95.00% |
| **M** | 12/18, 66.67% | 6/18, 33.33% |
| **$X^2$** | < 0.0001* | |
| **Fisher Exact 2-Tail** | < 0.0001* | |

In order to truly confirm the previously mentioned pattern was the case, a comparison between the two temporal periods based on biological sex was carried out in the same manner as all previous tests.  Table 16 demonstrates that there is, indeed, a significant difference between the body postures of females between time periods (p = <0.0001 for both $\chi^2$ and Fisher Exact tests), but there is no significant difference in the body posture of males between time periods ($\chi^2$ p = 0.4556; Fisher Exact 2-tail p = 0.7112).

**Table 16. Comparison of burial postures between temporal periods by biological sex (count/total, %).**

| | Biological Sex | | | |
|---|---|---|---|---|
| | F | | M | |
| Component | Extended | Flexed | Extended | Flexed |
| MW | 25/26, 96.15% | 1/26, 3.85% | 14/18, 77.78% | 4/18, 22.22% |
| LW | 1/20, 5.00% | 19/20, 95.00% | 12/18, 66.67% | 6/18, 33.33% |
| $X^2$ | < 0.0001* | | 0.4556 | |
| Fisher Exact 2-Tail | < 0.0001* | | 0.7112 | |

Table 17 (below) shows the distribution of burial postures between age cohorts in each time period, and when tested using a Fisher's Exact test, there were no significant differences identified within each time period based on age.

**Table 17. Comparison of burial postures within temporal periods by age cohort (count/total, %).**

| | Temporal Component | | | |
|---|---|---|---|---|
| | MW | | LW | |
| Age Cohort | Extended | Flexed | Extended | Flexed |
| Young Adult | 4/6, 66.67% | 2/6, 33.33% | 9/21, 42.86% | 12/21, 57.14% |
| Middle Adult | 13/15, 86.67% | 2/15, 13.33% | 3/8, 37.50% | 5/8, 62.50% |
| Old Adult | 22/23, 95.65% | 1/23, 4.35% | 1/9, 11.11% | 8/9, 88.89% |

However, when burial posture was tested by individual age cohorts between time periods, there were some significant differences identified. Table 18 shows the distribution of individuals in either extended or flexed posture based on age cohort for either time period, as well as the result of the Fisher's Exact test that was used to identify relationships because of low sample counts.

**Table 18. Comparison of burial postures in adult age cohorts between temporal components.**

| | Age Category (Count/Observed, %) | | | | | |
|---|---|---|---|---|---|---|
| **Component** | **Young Adult Extended** | **Young Adult Flexed** | **Middle Adult Extended** | **Middle Adult Flexed** | **Old Adult Extended** | **Old Adult Flexed** |
| **MW** | 4/6, 66.67% | 2/6, 33.33% | 13/15, 86.67% | 2/15, 13.33% | 22/23, 95.65% | 1/23, 4.35% |
| **LW** | 9/21, 42.86% | 12/21, 57.14% | 3/8, 37.50% | 5/8, 62.50% | 1/9, 11.11% | 8/9, 88.89% |
| **Fisher Exact 2-Tail** | 0.3845 | | 0.0257* | | < 0.0001* | |

From these results, it is evident that in the Late Woodland period, the Middle and the Old Adult age cohorts were more likely to be buried in a flexed rather than in an extended position. However, the posture of Young Adults was not changed significantly between time periods despite the significant increase of young adult burials in the Late Woodland period (see Table 2).

**Inclusion of grave goods.** Besides the burial of the physical body of an individual, many times there is the placement of other physical bodies, or grave goods, around the human body. These goods come in a variety of forms depending on the time and the culture that is being observed. At a baseline level, in order to get a better understanding of general patterns of grave good inclusions, a simple quantitative analysis of the presence or absence of goods from the individual burials was initially carried out for this study. Later discussion will then be spent on the qualitative attributes of the burial goods in Chapter VI as to garner a more holistic perspective on the burial rites within and between the Middle and Late Woodland periods. An abridged list of individuals who were buried with grave goods and what types of goods those were can be found in Appendix B.

For the analysis of grave goods at the Elizabeth site, all individuals including non-adult individuals were included as others have suggested that in the Late Woodland period, grave goods are more commonly found in the burials of non-adults (Farnsworth and Emerson 1986). The total number of non-adult and adult individuals for this segment of the analysis of the Elizabeth site is 151 (Middle Woodland n = 77 and Late Woodland n = 74).

Comparing the presence and absence of grave goods by biological sex between the Middle and Late Woodland periods (with an added "Indeterminate" sex for the non-adult population segment) does not show any significant difference (Table 19).

**Table 19. Comparison of burials with and without grave goods by biological sex between temporal components. A third group of "Indeterminate" sex was included for non-adult individuals.**

| | Biological Sex (Count/Observed, %) | | | | | |
|---|---|---|---|---|---|---|
| **Component** | **Indeterminate Absent** | **Indeterminate Present** | **Female Absent** | **Female Present** | **Male Absent** | **Male Present** |
| **MW** | 24/31, 77.42% | 7/31, 22.58% | 20/27, 74.07% | 7/27, 25.93% | 15/19, 78.95% | 4/19, 21.05% |
| **LW** | 27/29, 93.10% | 2/29, 6.90% | 20/23, 86.96% | 3/23, 13.04% | 15/22, 68.18% | 7/22 31.82% |
| **Fisher Exact 2-Tail** | 0.1478 | | 0.3079 | | 0.4993 | |

However, within the Late Woodland period, there are significantly more male individuals buried with grave goods (Fisher Exact p = 0.0341) than not (Table 20).

**Table 20. Comparison of presence and absence of grave goods by biological sex within temporal components.**

| Biological Sex (Count/Observed, %) | | | | | | |
|---|---|---|---|---|---|---|
| **Grave Goods** | **MW Indeterminate** | **MW Female** | **MW Male** | **LW Indeterminate** | **LW Female** | **LW Male** |
| **Absent** | 24/31, 77.42% | 20/27, 74.07% | 15/19, 78.95% | 27/29, 93.10% | 20/23, 86.96% | 15/22, 68.18% |
| **Present** | 7/31, 22.58% | 7/27, 25.93% | 4/19, 21.05% | 2/29, 6.90% | 3/23, 13.04% | 7/22, 31.82% |
| **Fisher Exact Pairs** | 1.0000 | 0.7802 | 1.0000 | 0.1103 | 0.7430 | 0.0341* |

Throughout the Middle Woodland period, the distribution of presence/absence of grave goods is relatively even for all three biological sex categories.

Quantitative analysis of grave good presence between the Middle and Late Woodland periods for individual age cohorts ("Non-adult" category was added to these analyses to account for the newly included non-adult population segment) via Fisher Exact Tests resulted in no significant differences (Tables 21-22).

**Table 21. Comparison of grave good presence in Non-Adult burials between temporal periods (count/total, %).**

| Temporal Component | Absent | Present |
|---|---|---|
| **MW** | 24/31, 77.42% | 7/31, 22.58% |
| **LW** | 31/33, 93.94% | 2/33, 6.06% |
| **Fisher Exact 2-Tail** | 0.0776 | |

**Table 22. Comparison of presence and absence of grave goods by adult age cohort between temporal components.**

| Adult Age Cohort (Count/Observed, %) | | | | | | |
|---|---|---|---|---|---|---|
| **Temporal Component** | **Young Adult Absent** | **Young Adult Present** | **Middle Adult Absent** | **Middle Adult Present** | **Old Adult Absent** | **Old Adult Present** |
| **MW** | 5/7, 71.43% | 2/7, 28.57% | 12/16, 75.00% | 4/16, 25.00% | 18/23, 78.26% | 5/23, 21.74% |
| **LW** | 13/20, 65.00% | 7/20, 35.00% | 11/11, 100.0% | 0/11, 0.00% | 7/10, 70.00% | 3/10 30.00% |
| **Fisher Exact Pairs** | 1.0000 | 1.0000 | 0.1225 | 0.1225 | 0.6728 | 0.6728 |

In the analyses presented in Tables 20 and 21, there is no significant difference in those buried with or without grave goods based on their chronological age.

It should be noted in the analysis of Indeterminate biological sex and Non-adult age cohorts, the numbers should be similar if not exactly the same because currently there is no reliable way to estimate the biological sex of a non-adult individual based on morphological comparisons. However, in the Elizabeth site collection there are some individuals who are sufficiently biologically mature to show sexually dimorphic characteristics while their chronological age does not fall into at least the Young Adult age category used in this study. Therefore, there is a discrepancy in the sample numbers in the comparisons tested above.

Despite the lack of differences between the two time periods, there is one recognizable pattern that was identified when looking within the time periods. Within the Late Woodland period, itself, the Young Adult population had an increased frequency of grave goods. The Middle Woodland period's distribution of grave goods showed no significant differences between the number of individuals buried with or without grave goods when partitioned by age (see Tables 23-24).

**Table 23. Comparison of presence and absence of grave goods by age cohort in the Middle Woodland period.**

| Grave Goods | Non-Adult | Young Adult | Middle Adult | Old Adult |
|---|---|---|---|---|
| **Absent** | 24/31, 11.11% | 5/7, 71.43% | 12/16, 75.00% | 18/23, 78.26% |
| **Present** | 7/31, 22.58% | 2/7, 28.57% | 4/16, 25.00% | 5/23, 21.74% |
| **Fisher Exact Pair** | 1.0000 | 0.6627 | 1.0000 | 1.0000 |

**Table 24. Comparison of presence and absence of grave goods by age cohort in the Late Woodland period.**

| Grave Goods | Non-Adult | Young Adult | Middle Adult | Old Adult |
|---|---|---|---|---|
| **Absent** | 31/33, 93.94% | 13/20, 65.00% | 11/11, 100.0% | 7/10, 70.00% |
| **Present** | 2/33, 6.06% | 7/20, 35.00% | 0/11, 0.00% | 3/10 30.00% |
| **Fisher Exact Pair** | 0.0547 | 0.0132* | 0.1930 | 0.3505 |

While the only significant difference in the analyses within time periods is found in the Young Adults of the Late Woodland period, it is also important to note that with the sample size of each group being low (especially in the Middle Adult cohort) that these patterns may not be reliable when compared to other sites of similar time periods.

**Characteristics of grave goods.** As was to be expected of the Middle Woodland period, the variation in grave goods is much greater than in the Late Woodland. In the Middle Woodland period, individuals were being buried with a number of ceramic vessels, platform pipes, animal bone pins, lithic blades, etc., and these are just what were preserved through time. The primary grave goods of the Late Woodland individuals at the Elizabeth site consist of shell beads and pendants, and several turtle shells with holes drilled into them and were likely to be rattles at the time of their internment.

Brief descriptions of all of the grave goods included with each individual's burial can be found in Appendix B, and detailed descriptions can be found in Charles et al. (1988). As can be seen in the descriptions of the buried grave goods, the variety of goods in the Middle Woodland period far outstrips that of the Late Woodland. However, it is the meaning behind the grave goods that is of particular interest. In the Middle Woodland period burials objects are largely made of, or made to represent, animals and the natural world. Take, for example, the imagery found on the pottery of Mound 7 Burial 13 (Feature 6). On these bowls and jars are stylized images of waterfowl, raptorial birds, and geometric patterns of flowing water (Figures 8-10).


Figure 8. Hopewell ware bowl from Elizabeth Mounds Mound 7 Feature 6, Cluster 4 Vessel 1 showing the image of a water bird (Photo courtesy of the Illinois State Museum).


Figure 9. Hopewell ware bowl from Elizabeth Mounds Mound 7 Feature 6, Cluster 4 Vessel 3 showing the image of a hook-billed bird (Photos courtesy of the Illinois State Museum).


Figure 10. Havana-Hopewell ware hybrid bowl from Elizabeth Mounds Mound 7 Feature 6, Cluster 6 Vessel 2 showing a series of flowing lines with zones of cord-wrapped-stick impressions, and design rollout (Photo and Rollout courtesy of the Illinois State Museum).

Alternatively, Mound 7 Burial 9 sk. 2 was buried with bone pins from Canadian Geese and turkeys, as well as with an assortment of shells, a coral pipe, and the remains of what may have been a copper object.

The stark contrast of the Late Woodland grave goods to the Middle Woodland grave goods, can easily be construed as a decline in richness or power. However, this is not necessarily the case. While the variation of grave goods is far less in the Late Woodland period, the frequency of individuals buried with goods is no less than in the Middle Woodland. However, instead of symbolic imagery from pots and pins, the remains are adorned with beaded jewelry and mussel shell pendants, and the individuals carry turtle shell rattles or the remains thereof. Personal adornment and objects such as these turtle shell rattles, in particular, point to the significance of the person (Figure 11).


Figure 11. Elizabeth Mounds Mound 5 Burial 5 close-up of Skeletons 2 and 3 with one of two recovered turtle shells that have holes drilled through each (Photo courtesy of the Illinois State Museum).

## VII. DISCUSSION OF WOODLAND HEALTH AND MORTURY PRACTICES AT ELIZABETH

The number of individuals buried at the Elizabeth site during the Woodland phases totals 157 people, 63 of which were non-adults and were not directly observed for the identification of pathological processes or other changes in biology within or between time periods. By eliminating the non-adult sub-sample of the population for biological descriptions, a total of 94 adult individuals were examined for the biological portion of this study.

The demographics of the population by biological sex are evenly distributed across the two time periods, but there is a significant shift in the age-at-death from the Middle to Late Woodland periods. More specifically, in the Late Woodland period, there is a significant increase in the proportion of Young Adult females and a significant decrease in the Old Adult females. The decrease in Old Adult females is expected with the increase of the Young Adult Female population because fewer individuals are surviving to old age. These shifts in the population are likely also representative of the population increase that is occurring in the Late Woodland period (Buikstra et al. 1986; Charles 1992). While the Middle Woodland period is also a period of increasing population, this period is also the time when the lower river valley is being resettled by the people and so the constant growth that leads into the Late Woodland, which is characterized as being a more established population within the valley, has likely reached an equilibrium in terms of population growth within a specific environment thus allowing the population to flourish. However, while these demographic shifts are present and demonstrate patterning across biological sex and age-at-death, any changes to the developmental health status of the individuals do not show patterning based on demographic segments. In the case of linear enamel hypoplasias (LEHs), there is a significant increase in the number of survivors of stress episodes in the Late Woodland period compared to the Middle Woodland, but there is no evidence for patterning based on biological sex or age cohort. Hypoplasias represent a disruption during dental development not linked to any one specific cause, such as a specific disease, and have been attributed to a general lack of resources such as food during childhood.

Average achieved stature estimates, another classic indicator of developmental stress, do not demonstrate a significant shift from the Middle to Late Woodland periods when compared for each biological sex. Achieved stature can be a difficult variable to interpret because while it can indicate developmental stress when matching an unknown individual into a population, when looking on a broader population level, a dramatic shift must be calculated for any significant conclusions to be drawn. When the samples are compared and there is no significant difference in the variance, one must be wary of concepts of catch-up growth and be sensitive to all confounding variables that play an effect to the development of an individual throughout the lifecourse. Alternatively, when looking for trends in a single population, such as the one at the Elizabeth site, an alternative variable that may be informative would be growth stunting in non-adults. By comparing the timing and number of stunting episodes in this segment of the population, a more meaningful pattern in developmental disruption may be possible to identify and pair with other lines of data such as LEH frequency because a sense of developmental or chronological timing is possible to also identify with these two variables. A second alternative variable to consider in place of achieved stature would be the development of degenerative joint disease (DJD) in the adult population. This variable has been tested by Pickering (1984) but from the perspective of developing a methodology to observe changing mechanical stress due to labor, and it has not been applied as a non-specific stress indicator. However, such a study would require a large sample size to identify any meaningful patterns.

The final biological variable described in this study, periostosis, is slightly different from the previous two non-specific stress indicators as it is not limited to developmental processes such as dental formation or long bone growth. Periostosis is a pathological process that can develop due to disease or trauma (very basically) and can be initiated at any point during the lifecourse of an individual, which includes adulthood. When comparing the two Woodland time periods in this study, there is a significant decrease in the frequency of periostosis of the tibia in any form (active, healing, or healed) from the Middle to Late period. This decrease is similarly mirrored when comparing the biological sex segments of the population from each time period, and this is much clearer in the female segment than the male segment, as well as in the Old Adult age cohort.

The presence of LEH and changes in stature can be thought of as disruptions to the homeostasis of the individual during skeletal/dental development likely influenced by resource availability. The presence of periostosis can similarly be thought of as a disruption to homeostasis, but it can develop at any point within the lifecourse and for a number of reasons but commonly from disease and trauma, and for acute or protracted time frames. For the sake of simplicity, in order to conceptualize and operationalize the concept of health as being any status besides "dead," i.e. the ultimate form of poor health, then by extension we can consider survival through a disruption of homeostasis as biological resilience and have a framework to consider non-specific stress indicators such as LEH, stature, and periostosis through other than the lens of vulnerability offered by the Osteological Paradox (Wood et al. 1992).

In the case of the Elizabeth Mounds site, there is an increased survivorship of individuals through developmental disruptions as evidenced by the increased frequency of LEHs. In other words, there were more children surviving through whatever difficulties they were facing into adulthood in the Late Woodland period. At the same time, the average stature of the population from the Middle to Late Woodland periods remained similar. The lack of change in adult statures could be indicative of any number of variations throughout childhood into adulthood so the most that can be concluded from this line of evidence is that there are no major disruptions to the population between these two periods in stature development. Finally, tibial periostosis frequency is significantly lower in the Late Woodland than in the Middle Woodland, and this shift is related to the female and Old Adult segments of the Late Woodland group. This pattern could be expected when considering the increasing population size in the Late Woodland period and by the fact that Old Adult females are also being buried less than Young Adult females during the time. Periostosis is different from LEH and stature in that it is not explicitly linked to biological development, although there are certainly instances when it can be. However, in this case it would be better to think of periostosis as an indicator of adult health. The results of periosteal analysis do not indicate an endemic reaction within the entire population and are rather specific instead.

These three lines of biological evidence combined do not indicate a population that was in poor health systemically. Instead, the changes represented from these analyses would seemingly indicate a more stable population that, when the perspective is shifted more broadly, point towards changes in the realm of entangled variables such as changing resource availability and exploitation, changing social roles, changes in social structures, etc. It is also critical to consider, however, that the individuals that make up this sample have all died, regardless of their biological sex or age-at-death, and that these samples are not representative of living populations. To get a better understanding of how these changes—or lack thereof—may come about then, we shift our focus away from the biological patterns into the mortuary patterns that clarify changes to the social structures of the Elizabeth Mounds people.

**Mortuary patterns of the Elizabeth Mounds Site.** The simplest variables for analysis of mortuary rites in the Elizabeth Mounds, in conjunction with the analysis of demographics and health status, were the burial postures and the grave good associations with individuals. A broad spatial analysis of the individuals and grave goods within the mounds (*sensu* Charles and Buikstra 1983; Kerber 1982, 1983, 1986) would have been possible and informative for this project. However, the patterns revealed from comparisons of burial postures and grave goods reveal some interesting insights into the deathways of these people.

The burial postures of the adult individuals mainly consisted of extended or flexed postures. The skeletons of the individuals buried in these postures were relatively complete and well preserved. Comparing these two postures across time and demographics, there is a clear shift from the Middle to Late Woodland period in preferred adult posture from extended to flexed positions. What is interesting about this shift, however, is not that it occurred but how it occurred. In the Middle Woodland period it is evident that males and females received similar treatment. However, in the Late Woodland period a change occurred for the females. The females of the Late Woodland period were the individuals more likely to be buried in a flexed position while males continued to be interred in an extended position. Taking a closer look at these results, the pattern exhibited in the Late Woodland is a pattern that occurred within the shift from Middle to Late Woodland periods due to the change in female burial treatment. This pattern is of further interest because from the Middle to Late Woodland periods, based on adult age cohorts, the posture of the deceased changed in the Middle and Old Adult populations and not the Young Adult cohort, which was where the overall change in demographics occurred for the sample population. So, while there was an increase in the number of Young Adult females buried in the Late Woodland period the changes in Late Woodland burial postures are most likely caused by a change in treatment of older adult females, although young adults of the Late Woodland are still more likely to be buried in a flexed posture. There are several variations of burial posture in both time periods, however, the extended and flexed postures make up a majority of the utilized postures and thus were the two considered for this basic analysis. However, there are other burial treatments, such as disarticulated individuals, that occurred in low frequencies and could not be statistically analyzed in the same way that extended or flexed burials could. One future line of research that can be explored is the possible meanings behind the different burial postures and their changes over time. Research questions that try to comprehend the meanings behind the postures and their changes over time would be useful in elaborating on ideas of identity and personhood that could easily be integrated into a behavioral ecology model such as the Adaptive Cycle and Resilience Theory. However, these ideas lay outside of the current project.

The quantitative analysis of grave good presence between these two time periods was enhanced by including the non-adult population of the Elizabeth site because, as previously discussed, it was hypothesized that grave goods were more likely to occur in the Late Woodland period non-adult burials. However, analysis of the presence or absence of grave goods in both the Middle and Late Woodland periods showed that this is not necessarily the case. The non-adult population was represented in analyses by being described either of “Indeterminate” biological sex or with an independent age cohort “0”. In considering the overall frequency of grave goods occurrence between the Middle and Late Woodland periods, no significant difference was calculated, and in the Middle Woodland period, it appears that the distribution of grave goods was relatively evenly distributed between biological sex and within age cohorts. However, in the Late Woodland period, males and the Young Adult individuals were more likely to be buried with grave goods. While quantitatively significant patterns are recognizable, interpreting changes to the sociocultural structures from these results alone should be approached conservatively, because one must look closely at what goods are being buried and not just with whom they are buried.

The materials and images of these sets of material objects are easily interpretable as references to the earthdiver myth that is also being invoked upon the land with the creation of the mounds themselves. The objects, representing the three realms of the cosmos of sky, middle, and under worlds, while being concentrated with only a few individuals serve to highlight the significance of this story to the group for whom these burials and mortuary rites are being performed by or enacted through.

Turtle shell rattles have been shown to be of ceremonial and sacred significance since 4000 B.C., and they are a personal equipment for carrying out rituals (Winters 1969; Buikstra et al. 1998). While not holding broad, significant meaning through the representation of the beliefs of the people, these individuals buried with tools and adornments that set them apart from other individuals were likely of significant social stature during life regarding the beliefs and values of the people whom they represented. For these individuals to be selectively interred in the mounds, only serves to support the idea that these individuals, themselves, could represent great significance for the people in place of elaborate grave goods.

Between the changes observed in burial postures and the grave goods recovered from the Woodland burials at the Elizabeth site, a larger picture can be formed. Broadly, the practice of mound building was preserved across this time. The significance of the mounds, and their representation of the earthdiver myth and the construction of the cosmos should hardly be necessary. However, to narrow the lens into the mounds themselves and those buried within becomes even more important to consider across time because there are distinct differences in who and how this myth is being represented. In the Middle Woodland period, the buried individuals represent the worldview and integration with the cosmos by representing or carrying representations of symbols from the earthdiver myth. Conversely, the individuals of the Late Woodland retain their more individual identities that they had during life in death, and instead have become actors through which ritual remembrance of group ideology was acted. While these individuals had become an integral part of the mound, their individual strengths were retained, or possibly even reborn into the world as represented by the fetal position in which they were commonly buried. The relative biological stability across the Middle to Late Woodland paired with these alterations to the mortuary practices likely represent changes to the sociocultural realm of the living as natural cycles of structures and powers take their course. However, without further contextualization—for Cannon (1989) this is a strong historical context—identifying these alterations to existing structures and dynamics is difficult in the prehistoric context.

The data collected and presented in this project have been divided into two different theoretical tracks for the sake of identifying meaningful patterns within and between the Middle and Late Woodland periods. However, the primary purpose of this study was to test whether the framework of Resilience Theory could be an accessible heuristic device for describing prehistoric populations. The concept of resilience was defined by Faulseit (2016: 6) as a group's vulnerability and its "ability to adapt to, cope with, or transform when facing both acute and chronic stresses." In order to conceptualize resilience in socio-ecological systems, ecologists have developed the idea of the Adaptive Cycle and a system of nested Adaptive Cycles known as Panarchy. With these two models as frameworks, archaeological and bioarchaeological data have been increasingly interpreted in attempts to describe behaviors and structures of past populations. Resilience Theory as described originally by Holling and Gunderson (2002) through the application of an Adaptive Cycle is readily accessible to both biological and archaeological data in tandem as the Cycle is established on the principle variables of "potential" and "connectedness". Potential refers to the biological potential of a system through accumulated resources and internally contained biomass. Connectedness then describes the strength of bonds between variables that guide behaviors external or internal to the system based on that strength (Holling and Gunderson 2002). The cycle within these two principle variables then is a tool by which past behaviors, decisions, and changes can be identified and connected.

In the example of the Elizabeth site, a biologically stable population in terms of accumulated "stress" has been described and can be further contextualized as a model population for what has been described of the Middle to Late Woodland transition as being a population that is increasing and expanding, but focusing group relations internally rather than inter-regionally as the classically described and sensationalized Hopewell. However, when the biological and demographic patterns identified are paired with the collected mortuary data and applied to well-established frameworks for identifying and describing social structures, behaviors, and ideas, a richer and more nuanced interpretation of the prehistoric population is possible.

To refer back to the Adaptive Cycle as a heuristic tool, the increasing biological potential that is accrued through the Middle and Late Woodland periods can be paired with the strengthening connectedness exhibited by the changing social potential of different demographic segments (i.e. greater inclusion of females in burials within the structured, corporate space of the community cemetery), as well as the decreasing focus on inter-regional relationships that had previously so defined the Middle Woodland period (i.e. the Hopewell). Reaching further back in time, it is understood that the lower Illinois River valley was the focus of resettlement during the Middle Woodland period because the peoples of the Terminal Archaic/early-Early Woodland period likely found the valley less than ideal to inhabit.  With the point of *re*settlement in mind, the idea of "reorganization" in the Adaptive Cycle comes to mind, and the unoccupied valley (once habitable) could be a land of great potential and "exploitation" for the peoples of the Middle Woodland.  Accruing available resources in the abundant landscape with the support of social structures such as a widely accepted worldview and earthdiver myths, in conjunction with a system of management practices, allocation mechanisms, and novel practices (like early plant domestication) allowed for a space of "conservation" and growth to occur into the Late Woodland period.  Thus, the idea of the Late Woodland being a dark age for the Native Peoples should be abandoned.  The evidence indicates that the Late Woodland was anything but a decline of the former Middle Woodland period, and instead can be considered a period of social resilience where peoples and ideologies continued to be a stable support while the bonds connecting the group continued to strengthen leading to new elaborations of social relations.

# VIII. CONCLUSIONS

In order to conceptualize the changes, transitions, and/or transformations to the Woodland sociocultural realm, the framework of Resilience Theory was selected because it attempts to explain the complex cycling of sociocultural systems through a naturalistic, behavior ecology perspective. LEH and stature were chosen as variables to consider changes during skeletal development that are correlated to resource availability, while tibial periostosis was selected to consider changes to disease load or trauma. The three variables reflect biological potential because of their connections to resource availability and population growth. Connectedness, the second axis of the Adaptive Cycle, was then considered through changes in mortuary practices that have been shown to reflect changes in socio-political ideals. As such, it was important to conceptualize and operationalize the set of variables that could be used to interpret the Woodland lifeways and deathways within this framework.

The selection of these biological variables was founded upon two major ideas. The first is that the discourse around the Osteological Paradox has classically focused upon the concept of vulnerability, but recent discourse is attempting to use the idea of survivorship to work around the problem of hidden heterogeneity in skeletal populations. By extension of the idea of survivorship, the idea of resilience (or a group's "ability to adapt to, cope with, or transform when facing both acute and chronic stresses.") can be discussed. The second key concept was that mortuary studies are able to engage the worldviews of a group in their life and in their death. So, to answer the questions above, there were identifiable changes in the frequency of LEH and periostosis of the tibiae between the Middle and Late Woodland periods. These changes, however, when paired with the lack of change to average achieved stature may indicate that neither period exhibits more “stress” than the other, and that the population can generally be considered to be within long term homeostasis. However, it is important to consider that using “achieved” stature is just that, achieved. If stature could be useful as a non-specific stress indicator, then there would need to be a significant difference or change from one time to another. However, when looking at adjacent time periods that can be considered to be in a biological equilibrium (or as much as can be inferred from a prehistoric skeletal population), the concept of achieved stature is limited. Instead it would be of more use to look at stunting episodes in non-adults that correlate to a stricter timeline of biological growth and development. Finally, achieved stature is limited by the fact that archaeologists can only look at an individual through the lens of the individual’s death. When considering that there is a protracted development of domesticated plants and advancement of maize agriculture occurring at the transition of cultural periods, accompanied by a change to the socio-economic system with the dissolution of the Hopewell Interaction Sphere. These two occurrences would easily impact any other sociocultural structures that were in place during the Woodland occupation at the Elizabeth site.

In conjunction with these biological changes, there are also changes that occur in the mortuary practices of the Woodland peoples. This study emphasized burial posture and grave goods because they were easily quantifiable along with the biological variables considered. Other variables such as spatial analyses and better demographic biographies could be developed, and taken into account in a broader, regional scope. However, there are visible changes in mortuary rites and biological processes that correlate temporally.

These rudimentarily modeled variables can also be contextualized with knowledge about mound building ceremonialism and changing corporate identities for a relatively more sophisticated interpretation of the time periods.

Within a broader context such as the lower Illinois River Valley, the idea of resilience would be applicable to modelling past lifeways. However, within the scope of the Elizabeth Mounds Site, we can begin to suggest productive concepts for further development. The population entombed in the mounds at this site model a relatively stable lifecourse across the Middle to Late Woodland periods. As Cannon (1989) suggested, it would be impractical to imagine there being no change to the underlying sociocultural structures of a group over a large expanse of time. Therefore, it is reasonable to think that changes in body posture, use of grave goods, symbology, and identity do not occur randomly. The evidence from the Elizabeth site suggests a model for a population in biological stasis has been revealed. In considering the adaptive cycle and the Panarchy then, a population in biological stasis is only one facet that should be considered. With the addition of evidence to social relations and structures from mortuary study theory, a model of increasing biological potential along with strengthening bonds of the local community has been broadly described. The advantage of examining past lifeways in the LIV is that cultural phases have been characterized and discussed in relation to one another rather despite some time periods being focused on more than others. Figure 12 depicts the Adaptive Cycle with the LIV temporal periods mapped onto it.

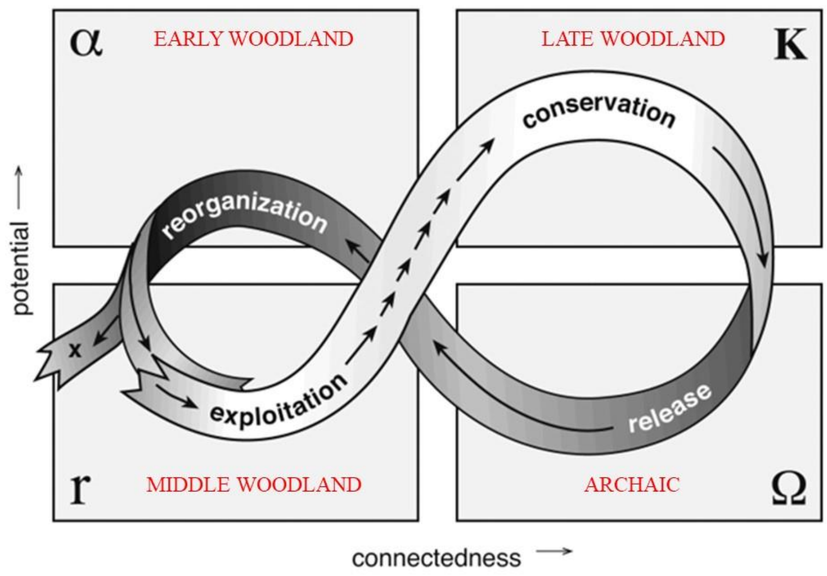


Figure 12. The Adaptive Cycle with cultural periods mapped onto it based on identified patterns in biological and mortuary variables in this study.

An advantage of considering the LIV through the lens of the Adaptive Cycle is that the Early Woodland period is practically invisible, and at the Elizabeth site that has an Archaic component, it could be considered that there is a distinct loss of biological potential and social connectedness. However, this should not be confused with cultural collapse as the evidence shows that Early Woodland lifeways continued elsewhere in the river valley. As such, the Early Woodland period should be considered a period of reorganization outside of an abandoned environment. The Middle Woodland period would then follow the reorganization of the Early Woodland peoples back into a vacant and productive environment into a period of exploitation. Exploitation being characterized by an increasing potential and connectedness. While scholars initially claimed that the Late Woodland period was a decline of the Middle Woodland lifeway, recent evidence and the results of this project suggests otherwise. In this study, the increased frequency of LEH and healed periosteal reactions with no change to achieved stature along with the changes to buried demographic groups, the obvious changes in burial postures, and the more subtle symbolic changes to grave goods support the idea of a growing population in conjunction with socio-political and economic changes. The Late Woodland period should not be considered a decline of the Middle Woodland and is not a simple continuation of Middle Woodland culture, but a stable period of growth. In terms of the Adaptive Cycle, the Late Woodland period is indicative of the conservation phase when there is moderate biological growth but a strong trend increasing connectedness. The late-Late Woodland period is not represented at the Elizabeth site but considering the broader LIV context, the Late Woodland period persisted longer than in neighboring regions and it is probable that the late-Late Woodland period is indicative of the downturn of the conservation period in the Adaptive Cycle. With more advanced and broader analyses, the intersections of cycles can likely be clarified within an adaptive or resilience model. While the limitations of this study are clear, the possibilities for working within the framework of Resilience Theory have become even more important and valuable.

# APPENDIX SECTION

## APPENDIX A: OSTEOLOGICAL DATA FROM CHARLES ET AL. 1988 AND COLLECTED BY AUTHOR

| Individual | Component | Sex | Age Category (1=YA, 2=MA, 3=OA) | LEH A/P/U (0, 1, 9) | Periostosis A/P/U (0/1/9) | Periostosis L/R/Bi | Periostosis Ab/A/M/H/U (0, 1, 2, 3, 9) | L FBL | R FBL | L TML | R TML | Male EQ 1 | Male EQ1 SEE | Male EQ 2 | Male EQ2 SEE | Male EQ 3 | Male EQ 3 SEE | Female EQ 1 | Female EQ1 SEE | Female EQ 2 | Female EQ 2 SEE | Female EQ 3 | Female EQ3 SEE | Stature Lower Bound | Stature Upper Bound | Stature Point Estimate | Burial Posture | Head Direction | Artifacts Associated (P/A) (1/0) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1-2-1 | MW | F | 2 | 0 | 9 | -- | 9 | 399.0 | 395.0 | - | - | | | | | | | 153.206 | 2.58 | - | - | - | - | 150.626 | 155.786 | 153.206 | Extended | W | 1 |
| 1-3-1 | MW | F | 2 | 0 | 1 | B | 3 | - | 447.0 | 369.0 | 371.0 | | | | | | | 164.918 | 2.58 | 161.189 | 2.97 | 164.23 | 2.41 | 161.82 | 166.64 | 164.23 | Extended | NE | 0 |
| 1-10-1 | MW | F | 3 | 0 | 1 | R | 3 | - | 425.0 | - | - | | | | | | | 159.55 | 2.58 | | 2.97 | | 2.41 | 156.97 | 162.13 | 159.55 | Extended | NW | 0 |
| 1-12-1 | MW | F | 2 | 1 | 1 | B | 3 | - | 428.0 | 345.0 | 347.0 | | | | | | | 160.282 | 2.58 | 154.973 | 2.97 | 158.542 | 2.41 | 156.132 | 160.952 | 158.542 | Extended | NW | 0 |
| 3-1-1 | MW | F | 2 | 0 | 1 | B | 2 | 447.0 | - | 370.0 | 369.0 | | | | | | | 164.918 | 2.58 | 160.93 | 2.97 | 164.126 | 2.41 | 161.716 | 166.536 | 164.126 | Extended | NW | 0 |
| 3-2-1 | MW | F | 3 | 1 | 0 | L | 0 | - | - | - | - | | | | | | | | 2.58 | | 2.97 | | 2.41 | - | - | - | Extended | S | 0 |
| 3-3-1 | MW | F | 3 | 1 | 1 | B | 2 | 424.0 | 425.0 | 360.0 | - | | | | | | | 159.306 | 2.58 | 158.34 | 2.97 | 159.222 | 2.41 | 156.812 | 161.632 | 159.222 | Extended | NE | 0 |
| 3-5-1 | MW | F | 2 | 9 | 0 | B | 0 | 430.0 | 426.0 | 358.0 | 364.0 | | | | | | | 160.77 | 2.58 | 157.822 | 2.97 | 160.022 | 2.41 | 157.612 | 162.432 | 160.022 | Extended | ENE | 0 |
| 3-12-1 | MW | F | 2 | 1 | 0 | B | 0 | [459] | 462.0 | 385.0 | - | | | | | | | 167.846 | 2.58 | 164.815 | 2.97 | 167.702 | 2.41 | 165.292 | 170.112 | 167.702 | Extended | NNE | 0 |
| 7-12-1 | MW | F | 2 | 0 | 0 | B | 0 | 440.0 | 441.0 | - | - | | | | | | | 163.21 | 2.58 | | 2.97 | | 2.41 | 160.63 | 165.79 | 163.21 | Extended | E | 1 |
| 7-21-1 | MW | F | 3 | 0 | 1 | B | 2 | 396.0 | 397.0 | 332.0 | 333.0 | | | | | | | 152.474 | 2.58 | 151.088 | 2.97 | 151.606 | 2.41 | 149.196 | 154.016 | 151.606 | Extended | NE | 0 |
| 1-3-2 | MW | F | 3 | 1 | 1 | B | 3 | 399.0 | 400.0 | 349.5 | - | | | | | | | 153.206 | 2.58 | 155.6205 | 2.97 | 153.93 | 2.41 | 151.52 | 156.34 | 153.93 | Extended | NE | 0 |
| 3-3-2 | MW | F | 3 | 1 | 1 | L | 3 | - | - | - | - | | | | | | | | 2.58 | | 2.97 | | 2.41 | - | - | - | Extended | NE | 0 |
| 7-9-2 | MW | F | 3 | 9 | 0 | B | 0 | - | - | - | - | | | | | | | | 2.58 | | 2.97 | | 2.41 | - | - | - | Extended | SW | 1 |
| 7-12-2 | MW | F | 3 | 1 | 0 | B | 0 | 439.0 | 432.0 | 360.0 | 361.0 | | | | | | | 162.966 | 2.58 | 158.34 | 2.97 | 161.742 | 2.41 | 159.332 | 164.152 | 161.742 | Extended | W | 1 |
| 7-16-2 | MW | F | 3 | 9 | 1 | B | 2 | 400.0 | - | - | 341.0 | | | | | | | 153.45 | 2.58 | 153.419 | 2.97 | | 2.41 | 150.87 | 156.03 | 153.45 | Extended | NW | 1 |
| 6-4-3 | MW | F | 1 | 1 | 0 | L | 0 | - | - | - | - | | | | | | | | 2.58 | | 2.97 | | 2.41 | - | - | - | Extended | NE | 1 |
| 6-4-5 | MW | F | 2 | 0 | 1 | L | 2 | - | - | - | - | | | | | | | | 2.58 | | 2.97 | | 2.41 | - | - | - | Extended | NE | 1 |
| 3-11 | MW | F | 3 | 0 | 1 | B | 2 | 404.0 | [402] | 346.0 | - | | | | | | | 154.426 | 2.58 | 154.714 | 2.97 | 154.406 | 2.41 | 151.996 | 156.816 | 154.406 | Extended | N | 0 |
| 3-13 | MW | F | 3 | 9 | 1 | B | 2 | 413.0 | - | - | - | | | | | | | 156.622 | 2.58 | | 2.97 | | 2.41 | 154.042 | 159.202 | 156.622 | Extended | S | 0 |
| 4-2 | MW | F | 3 | 1 | 0 | - | 0 | 435.0 | - | - | - | | | | | | | 161.99 | 2.58 | | 2.97 | | 2.41 | 159.41 | 164.57 | 161.99 | Extended | N | 1 |
| 4-3 | MW | F | 3 | 0 | 1 | B | 3 | 424.0 | 422.0 | - | - | | | | | | | 159.306 | 2.58 | | 2.97 | | 2.41 | 156.726 | 161.886 | 159.306 | Atypical | - | 0 |
| 7-1 | MW | F | 3 | 1 | 1 | B | 2 | - | - | - | - | | | | | | | | 2.58 | | 2.97 | | 2.41 | - | - | - | Extended | W | 0 |
| 7-5 | MW | F | 2 | 0 | 1 | B | 3 | - | 455.0 | - | 383.0 | | | | | | | 166.87 | 2.58 | 164.297 | 2.97 | 166.822 | 2.41 | 164.412 | 169.232 | 166.822 | Extended | S | 0 |
| 7-6 | MW | F | 3 | 1 | 1 | R | 3 | - | - | - | - | | | | | | | | 2.58 | | 2.97 | | 2.41 | - | - | - | Extended | N | 0 |
| 7-18 | MW | F | 3 | 9 | 1 | B | 2 | 402.0 | 398.5 | 342.0 | 341.0 | | | | | | | 153.938 | 2.58 | 153.678 | 2.97 | 153.654 | 2.41 | 151.244 | 156.064 | 153.645 | Extended | N | 0 |
| 3-7-1 (Dwarf) | MW | F | 1 | 1 | 1 | B | 2 | 217.0 | 213.0 | 194.0 | - | | | | | | | 108.798 | 2.58 | 115.346 | 2.97 | 107.182 | 2.41 | 104.772 | 109.592 | 107.182 | Flexed | N | 0 |
| 1-33 | MW | M | 3 | 0 | 0 | B | 0 | 462.0 | - | - | - | 170.958 | 2.05 | | 2.77 | | 1.94 | | | | | | | 168.91 | 173.01 | 170.958 | Extended | SW | 1 |
| 6-1-1 | MW | M | 1 | 9 | 1 | R | 2 | - | - | - | - | | 2.05 | | 2.77 | | 1.94 | | | | | | | - | - | - | Extended | N | 0 |
| 6-4-1 | MW | M | 1 | 0 | 1 | B | 3 | - | 440.0 | - | - | 165.59 | 2.05 | | 2.77 | | 1.94 | | | | | | | 163.54 | 167.64 | 165.59 | Extended | SW | 0 |
| 7-8-1 | MW | M | 2 | 9 | 1 | B | 2 | - | - | - | - | | 2.05 | | 2.77 | | 1.94 | | | | | | | - | - | - | Flexed | E | 1 |
| 1-10-2 | MW | M | 3 | 0 | 0 | B | 0 | 448.0 | - | 396.0 | - | 167.542 | 2.05 | 170.834 | 2.77 | 168.45 | 1.94 | | | | | | | 166.51 | 170.39 | 168.45 | Extended | NW | 0 |
| 1-12-2 | MW | M | 3 | 0 | 1 | B | 3 | 456.0 | 455.0 | 390.0 | 391.0 | 169.494 | 2.05 | 169.34 | 2.77 | 169.498 | 1.94 | | | | | | | 167.558 | 171.438 | 169.498 | Extended | NW | 0 |
| 3-2-2 | MW | M | 2 | 1 | 0 | B | 0 | 483.0 | 504.0 | - | 411.0 | 181.206 | 2.05 | 174.569 | 2.77 | 180.118 | 1.94 | | | | | | | 178.178 | 182.058 | 180.118 | Extended | S | 0 |
| 3-5-2 | MW | M | 1 | 1 | 0 | B | 0 | 414.0 | 412.0 | 367.0 | 367.0 | 159.246 | 2.05 | 163.613 | 2.77 | 159.854 | 1.94 | | | | | | | 157.914 | 161.794 | 159.854 | Extended | ENE | 1 |
| 6-4-2 | MW | M | 1 | 1 | 0 | B | 0 | - | - | - | - | | 2.05 | | 2.77 | | 1.94 | | | | | | | - | - | - | Flexed | NE | 0 |
| 7-21-2 | MW | M | 3 | 9 | 0 | B | 0 | 428.0 | 424.0 | 355.0 | 356.0 | 162.662 | 2.05 | 160.625 | 2.77 | 161.574 | 1.94 | | | | | | | 159.634 | 163.514 | 161.574 | Extended | NE | 0 |
| 1-10-3 | MW | M | 3 | 1 | 1 | B | 3 | 437.0 | - | 377.0 | - | 164.858 | 2.05 | 166.103 | 2.77 | 164.938 | 1.94 | | | | | | | 162.998 | 166.878 | 164.938 | Extended | NE | 0 |
| 1-10-4 | MW | M | 2 | 1 | 9 | - | 9 | - | - | - | - | | 2.05 | | 2.77 | | 1.94 | | | | | | | - | - | - | Atypical | - | 0 |
| 6-4-6 | MW | M | 3 | 0 | 1 | B | 3 | - | - | - | - | | 2.05 | | 2.77 | | 1.94 | | | | | | | - | - | - | Extended | NE | 0 |
| 1-4 | MW | M | 2 | 1 | 0 | B | 0 | 443.0 | 444.0 | 371.0 | 372.0 | 166.322 | 2.05 | 164.609 | 2.77 | 165.61 | 1.94 | | | | | | | 163.67 | 167.55 | 165.61 | Flexed | SE | 0 |
| 3-10 | MW | M | 3 | 1 | 0 | B | 0 | - | - | - | - | | 2.05 | | 2.77 | | 1.94 | | | | | | | - | - | - | Flexed | SE | 0 |
| 4-1 | MW | M | 2 | 1 | 0 | B | 0 | 455.0 | 451.0 | - | 387.0 | 168.274 | 2.05 | 168.593 | 2.77 | 168.33 | 1.94 | | | | | | | 166.39 | 170.27 | 168.33 | Extended | NE | 0 |
| 7-2 | MW | M | 2 | 1 | 1 | B | 2 | 463.0 | 461.0 | 386.0 | 390.0 | 171.202 | 2.05 | 168.344 | | 170.51 | 1.94 | | | | | | | 168.57 | 172.45 | 170.51 | Extended | S | 0 |
| 7-3 | MW | M | 3 | 0 | 1 | B | 3 | - | - | - | - | | 2.05 | | 2.77 | | 1.94 | | | | | | | - | - | - | Extended | N | 0 |
| 7-19 | MW | M | 2 | 1 | 1 | B | 2 | 422.0 | 414.0 | 378.0 | 388.0 | 161.198 | 2.05 | 166.352 | 2.77 | 162.194 | 1.94 | | | | | | | 160.254 | 164.134 | 162.194 | Extended | N | 1 |
| 3-F1-1 | MW | M | 1 | 1 | 9 | - | 9 | - | - | - | - | | 2.05 | | 2.77 | | 1.94 | | | | | | | - | - | - | Atypical | - | 0 |
| 3-F1-2 | MW | M | 2 | 1 | 9 | - | 9 | - | - | - | - | | 2.05 | | 2.77 | | 1.94 | | | | | | | - | - | - | Atypical | - | 0 |
| 3-F1-3 | MW | M | 1 | 1 | 9 | - | 9 | - | - | - | - | | 2.05 | | 2.77 | | 1.94 | | | | | | | - | - | - | Atypical | - | 0 |
| 3-F1-4 | MW | M | 1 | 1 | 9 | - | 9 | - | - | - | - | | 2.05 | | 2.77 | | 1.94 | | | | | | | - | - | - | Atypical | - | 0 |
| 3-F1-5 | MW | M | 1 | 1 | 9 | - | 9 | - | - | - | - | | 2.05 | | 2.77 | | 1.94 | | | | | | | - | - | - | Atypical | - | 0 |
| 3-F1-6 | MW | M | 3 | 0 | 9 | - | 9 | - | - | - | - | | 2.05 | | 2.77 | | 1.94 | | | | | | | - | - | - | Atypical | - | 0 |

| Individual | Component | Sex | Age Category (1=YA, 2=MA, 3=OA) | LEH A/P/U (0, 1, 9) | Periostosis A/P/U (0/1/9) | Periostosis L/R/Bi | Periostosis Ab/A/M/H/U (0, 1, 2, 3, 9) | L FBL | R FBL | L TML | R TML | Male EQ 1 | Male EQ1 SEE | Male EQ 2 | Male EQ2 SEE | Male EQ 3 | Male EQ 3 SEE | Female EQ 1 | Female EQ1 SEE | Female EQ 2 | Female EQ 2 SEE | Female EQ 3 | Female EQ3 SEE | Stature Lower Bound | Stature Upper Bound | Stature Point Estimate | Burial Posture | Head Direction | Artifacts Associated (P/A) (1/0) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5-5-1 | LW | F | 2 | 0 | 1 | B | 3 | 441.0 | 444.5 | 373.0 | 373.0 | | | | | | | 163.454 | 2.58 | 161.707 | 2.97 | 163.43 | 2.41 | 161.02 | 165.84 | 163.43 | Flexed | W | 0 |
| 10-5-1 | LW | F | 1 | 1 | 1 | L | 3 | 420.0 | 417.0 | - | 345.0 | | | | | | | 157.598 | 2.58 | 154.455 | 2.97 | 156.486 | 2.41 | 154.076 | 158.896 | 156.486 | Flexed | NNE | 0 |
| 12-3-1 | LW | F | 1 | 1 | 0 | B | 0 | 394.0 | 396.5 | 336.0 | 333.0 | | | | | | | 151.986 | 2.58 | 152.124 | 2.97 | 151.686 | 2.41 | 149.276 | 154.096 | 151.686 | Flexed | NW | 1 |
| 5-5-2 | LW | F | 3 | 0 | 0 | B | 0 | 430.0 | 427.0 | 360.0 | 363.0 | | | | | | | 160.77 | 2.58 | 158.34 | 2.97 | 160.23 | 2.41 | 157.82 | 162.64 | 160.23 | Flexed | E | 0 |
| 9-6-2 | LW | F | 1 | 1 | 1 | B | 3 | 436.0 | 431.0 | 355.0 | 360.0 | | | | | | | 162.234 | 2.58 | 157.045 | 2.97 | 160.718 | 2.41 | 158.308 | 163.128 | 160.718 | Flexed | WNW | 0 |
| 10-2-2 | LW | F | 1 | 1 | 0 | B | 0 | - | - | - | - | | | | | | | | 2.58 | | 2.97 | | 2.41 | - | - | - | Atypical | - | 0 |
| 5-3 | LW | F | 1 | 0 | 1 | B | 3 | 446.0 | 443.0 | 356.0 | 370.0 | | | | | | | 164.674 | 2.58 | 157.304 | 2.97 | 162.502 | 2.41 | 160.092 | 164.912 | 162.502 | Flexed | NW | 0 |
| 5-4 | LW | F | 3 | 1 | 1 | B | 2 | 420.0 | 423.0 | 351.0 | 354.0 | | | | | | | 158.33 | 2.58 | 156.009 | 2.97 | 157.614 | 2.41 | 155.204 | 160.024 | 157.614 | Flexed | N | 0 |
| 9-8 | LW | F | 1 | 1 | 9 | - | 9 | - | - | - | - | | | | | | | | 2.58 | | 2.97 | | 2.41 | - | - | - | Flexed | ESE | 0 |
| 10-7 | LW | F | 3 | 9 | 0 | B | 0 | - | 408.0 | - | - | | | | | | | 155.402 | 2.58 | | 2.97 | | 2.41 | 152.822 | 157.982 | 155.402 | Flexed | W | 0 |
| 10-11 | LW | F | 2 | 1 | 0 | B | 0 | 446.0 | 449.0 | - | 372.0 | | | | | | | 165.406 | 2.58 | 161.448 | 2.97 | 164.67 | 2.41 | 162.26 | 167.08 | 164.67 | Flexed | W | 0 |
| 10-13 | LW | F | 1 | 1 | 0 | L | 0 | - | - | - | - | | | | | | | | 2.58 | | 2.97 | | 2.41 | - | - | - | Flexed | E | 0 |
| 11-4 | LW | F | 2 | 1 | 9 | - | 9 | - | - | - | - | | | | | | | | 2.58 | | 2.97 | | 2.41 | - | - | - | Flexed | N | 0 |
| 12-4 | LW | F | 1 | 1 | 0 | B | 0 | 396.0 | 402.0 | 330.0 | 330.5 | | | | | | | 152.474 | 2.58 | 150.57 | 2.97 | 151.398 | 2.41 | 148.988 | 153.808 | 151.398 | Extended | NE | 1 |
| 12-5 | LW | F | 3 | 0 | 1 | R | 3 | 394.0 | 384.0 | 323.0 | 322.0 | | | | | | | 151.986 | 2.58 | 148.757 | 2.97 | 150.334 | 2.41 | 147.924 | 152.744 | 150.334 | Atypical | - | 1 |
| 13-1-2 | LW | F | 3 | 1 | 0 | B | 0 | - | - | - | - | | | | | | | | 2.58 | | 2.97 | | 2.41 | - | - | - | Flexed | - | 0 |
| 13-3 | LW | F | 2 | 1 | 0 | B | 0 | 437.0 | 439.0 | 369.0 | - | | | | | | | 162.478 | 2.58 | 160.671 | 2.97 | 162.342 | 2.41 | 159.932 | 164.752 | 162.342 | Flexed | NNE | 0 |
| Knoll A-1-1 | LW | F | 1 | 1 | 0 | B | 0 | 429.0 | 428.0 | 370.0 | 373.0 | | | | | | | 160.526 | 2.58 | 160.93 | 2.97 | 161.102 | 2.41 | 158.692 | 163.512 | 161.102 | Flexed | NW | 0 |
| Knoll A-1-2 | LW | F | 1 | 0 | 1 | B | 1 | 455.0 | 453.0 | 384.0 | 387.0 | | | | | | | 166.87 | 2.58 | 164.556 | | 166.926 | 2.41 | 164.516 | 169.336 | 166.926 | Flexed | WNW | 1 |
| Knoll B-1 | LW | F | 1 | 1 | 0 | B | 0 | 423.5 | 426.0 | 354.0 | 357.0 | | | | | | | 159.184 | 2.58 | 156.786 | 2.97 | 158.514 | 2.41 | 156.104 | 160.924 | 158.514 | Flexed | NNW | 0 |
| Knoll E-1-2 | LW | F | 3 | 1 | 0 | B | 0 | 404.0 | 409.0 | - | 328.0 | | | | | | | 155.646 | 2.58 | 150.052 | 2.97 | 153.374 | 2.41 | 150.964 | 155.784 | 153.374 | Flexed | NW | 0 |
| Knoll E-4 | LW | F | 1 | 1 | 1 | B | 3 | - | 401.0 | 331.0 | 336.0 | | | | | | | 153.694 | 2.58 | 152.124 | 2.97 | 152.862 | 2.41 | 150.452 | 155.272 | 152.862 | Flexed | NE | 0 |
| 9-1-1 | LW | M | 1 | 1 | 0 | B | 0 | 401.0 | 404.5 | 339.0 | 340.0 | 156.074 | 2.05 | 156.641 | 2.77 | 155.282 | 1.94 | | | | | | | 153.342 | 157.222 | 155.282 | Extended | N | 1 |
| 9-6-1 | LW | M | 3 | 1 | 0 | B | 0 | 482.0 | 478.0 | - | 403.0 | 174.862 | 2.05 | 172.577 | 2.77 | 174.622 | 1.94 | | | | | | | 172.682 | 176.562 | 174.622 | Flexed | WNW | 1 |
| 10-6-1 | LW | M | 1 | 1 | 1 | R | 3 | - | - | - | 356.0 | | 2.05 | 160.874 | 2.77 | | 1.94 | | | | | | | 158.104 | 163.644 | 160.874 | Extended | N | 1 |
| 10-17-1 | LW | M | 3 | 1 | 0 | B | 0 | 455.0 | 454.0 | 385.0 | - | 169.25 | 2.05 | 168.095 | 2.77 | 168.93 | 1.94 | | | | | | | 166.99 | 170.87 | 168.93 | Extended | N | 1 |
| 5-5-3 | LW | M | 1 | 0 | 0 | B | 0 | 455.0 | 455.0 | 393.0 | 390.0 | 169.25 | 2.05 | 170.087 | 2.77 | 169.538 | 1.94 | | | | | | | 167.598 | 171.478 | 169.538 | Extended | E | 1 |
| 1-15 | LW | M | 1 | 1 | 1 | B | 2 | 461.0 | 455.0 | 381.0 | 382.0 | 170.714 | 2.05 | 167.099 | 2.77 | 169.754 | 1.94 | | | | | | | 167.814 | 171.694 | 169.754 | Flexed | E | 1 |
| 9-2 | LW | M | 2 | 1 | 0 | B | 0 | 440.0 | 435.0 | 378.0 | 378.0 | 165.59 | 2.05 | 166.352 | 2.77 | 165.578 | 1.94 | | | | | | | 163.638 | 167.518 | 165.578 | Extended | N | 0 |
| 9-7 | LW | M | 3 | 1 | 0 | B | 0 | 453.0 | 449.0 | 386.0 | - | 168.762 | 2.05 | 168.344 | 2.77 | 168.63 | 1.94 | | | | | | | 166.69 | 170.57 | 168.63 | Flexed | NW | 0 |
| 10-14 | LW | M | 1 | 1 | 0 | B | 0 | 459.0 | - | - | - | 170.226 | 2.05 | | 2.77 | | 1.94 | | | | | | | 168.18 | 172.28 | 170.226 | Extended | N | 1 |
| 10-15 | LW | M | 1 | 1 | 0 | B | 0 | 435.0 | 434.0 | 372.0 | 368.0 | 164.37 | 2.05 | 164.858 | 2.77 | 164.182 | 1.94 | | | | | | | 162.242 | 166.122 | 164.128 | Extended | SW | 0 |
| 10-16 | LW | M | 1 | 1 | 0 | R | 0 | - | - | - | - | | 2.05 | | 2.77 | | 1.94 | | | | | | | - | - | - | Extended | N | 0 |
| 11-3 | LW | M | 2 | 9 | 0 | R | 0 | - | - | - | - | | 2.05 | | 2.77 | | 1.94 | | | | | | | - | - | - | Atypical | W | 0 |
| 11-5 | LW | M | 1 | 1 | 0 | B | 0 | 426.0 | [422] | 354.0 | 356.0 | 162.174 | 2.05 | 160.376 | 2.77 | 161.122 | 1.94 | | | | | | | 159.182 | 163.062 | 161.122 | Extended | N | 0 |
| 13-1-1 | LW | M | 2 | 9 | 0 | R | 0 | - | 420.0 | - | 352.0 | 160.71 | 2.05 | 159.878 | 2.77 | 159.842 | 1.94 | | | | | | | 157.902 | 161.782 | 159.842 | Extended | - | 0 |
| 13-4-1 | LW | M | 3 | 1 | 0 | B | 0 | - | - | - | - | | 2.05 | | 2.77 | | 1.94 | | | | | | | - | - | - | Flexed | - | 0 |
| Knoll E-1-1 | LW | M | 1 | 1 | 1 | B | 3 | 492.5 | 486.0 | [391] | 395.0 | 178.4 | 2.05 | 169.589 | 2.77 | 176.436 | 1.94 | | | | | | | 174.496 | 178.376 | 176.436 | Flexed | NW | 0 |
| Knoll E-2 | LW | M | 2 | 1 | 0 | B | 0 | - | - | 379.0 | 379.0 | | 2.05 | 166.601 | 2.77 | | 1.94 | | | | | | | 163.831 | 169.371 | 166.601 | Atypical | - | 0 |
| Knoll E-3-1 | LW | M | 2 | 1 | 0 | B | 0 | - | 445.0 | 374.0 | 374.0 | 166.81 | 2.05 | 165.356 | 2.77 | 166.214 | 1.94 | | | | | | | 164.274 | 168.154 | 166.214 | Flexed | - | 0 |
| Knoll E-3-2 | LW | M | 2 | 0 | 1 | R | 2 | 453.0 | 455.0 | 370.0 | 374.0 | 168.762 | 2.05 | 164.36 | 2.77 | 167.414 | 1.94 | | | | | | | 165.474 | 169.354 | 167.414 | Extended | - | 0 |
| Knoll E-6 | LW | M | 1 | 1 | 0 | B | 0 | 471.0 | 470.0 | 384.0 | 387.0 | 173.154 | 2.05 | 167.846 | 2.77 | 171.862 | 1.94 | | | | | | | 169.922 | 173.802 | 171.862 | Extended | N | 0 |

# APPENDIX B: BURIALS WITH ACCOMPANYING GRAVE GOOD DESCRIPTIONS

<table>
<tr><th>Individual</th><th>Temporal Component</th><th>Biological Sex</th><th>Age Cohort</th><th>Grave Good Description</th></tr>
<tr><td>1-33</td><td>MW</td><td>M</td><td>OA</td><td>One Ohio pipestone Bedford pipe, one limestone pipe preform, and one type-indeterminate projectile point</td></tr>
<tr><td>1-15</td><td>LW</td><td>M</td><td>YA</td><td>Two Klunk points, six Madison Points, one Middle Archaic corner notched point, one type indeterminate point, and two Late Woodland ceramic body sherds in the pit fill</td></tr>
<tr><td>3-4</td><td>MW</td><td>I</td><td>N-A</td><td>One cut and polished mussel shell on shoulder; two polished, longitudinally drilled teeth at left wrist</td></tr>
<tr><td>3-5-2</td><td>MW</td><td>M</td><td>YA</td><td>Single, large lamellar blade</td></tr>
<tr><td>4-2</td><td>MW</td><td>F</td><td>OA</td><td>Hopewell Zoned Stamped var. rocked dentate bowl next to head and above right shoulder. Bowl was on its side, but may have fallen in position as flesh decayed. There was a mussel shell inside the bowl.</td></tr>
<tr><td>5-5-3</td><td>LW</td><td>M</td><td>YA</td><td>Two complete turtle shells with holes drilled through them were lying near the waist of the individual on the left side</td></tr>
<tr><td>6-2</td><td>MW</td><td>I</td><td>N-A</td><td>One small Hopewell Zoned Stamped var. rocked dentate jar of extremely poor preservation with a mussel shell placed in the bottom</td></tr>
<tr><td>6-4-3</td><td>MW</td><td>F</td><td>YA</td><td>Single elk metapodial pin</td></tr>
<tr><td>6-4-5</td><td>MW</td><td>F</td><td>MA</td><td>Single elk metapodial pin</td></tr>
<tr><td>7-8-1</td><td>MW</td><td>M</td><td>MA</td><td>Single Havana Zoned Incised jar</td></tr>
<tr><td>7-9-1</td><td>MW</td><td>I</td><td>N-A</td><td>4 perforated dog or wolf canines at the neck</td></tr>
<tr><td>7-9-2</td><td>MW</td><td>F</td><td>OA</td><td>Nine lamellar blades; a turtle carapace; five mussel shells with serrated edges; 24 sharpened Canada Goose radii pins; 23 sharpened turkey tarsometatarsal bone pins; copper stained soil near right shoulder; fossil coral pipe under the skull</td></tr>
<tr><td>7-10</td><td>MW</td><td>I</td><td>N-A</td><td>Single quadrilobate jar (Hopewell Zoned Stamped var. rocked dentate) beneath the head</td></tr>
<tr><td>7-12-1</td><td>MW</td><td>F</td><td>MA</td><td>Beaver effigy pipe with copper-peg nose and cross-hatched tail under the skull</td></tr>
<tr><td>7-12-2</td><td>MW</td><td>F</td><td>OA</td><td rowspan="2">Five ceramic vessels, eight squirrel crania, and six unmodified mussel shells. Vessels 1 and 2 are Naples Stamped var. dentate jars. Vessels 3 and 4 are Hopewell Zoned Incised jars. Vessel 5 is a small, plain type indeterminate jar.</td></tr>
<tr><td>7-12-3</td><td>MW</td><td>I</td><td>N-A</td></tr>
</table>

| | | | | |
|---|---|---|---|---|
| 7-13 | MW | I | N-A | 20 ceramic vessels, three modified *Cassio madagascarensis* shells, one box turtle carapace |
| 7-16-2 | MW | F | OA | One Hannibal shale platform pipe between the right shoulder and the head |
| 7-17 | MW | I | N-A | One left and one right coyote mandible, both cut and ground, and each with a hole drilled through it. Accompanying the mandible sections were approximately 130 marine shell beads each roughly 3 mm in diameter. These items were located at the right wrist, but were not around the wrist as a bracelet. |
| 7-19 | MW | M | MA | One platform pipe of Hannibal shale located between the left shoulder and the skull |
| 7-22 | MW | I | N-A | *Lynx rufus* (Bobcat) burial. Two modified bones shaped like large-carnivore canines and drilled, along with four beads. Three beads are marine shell, and the fourth appears to be river pearl. |
| 9-1-1 | LW | M | YA | Single mussel-shell pendant beneath cervical vertebrae near base of skull. The shell was polished, with incised notches along the margin. The concave side lay downward, with a corkscrew-shaped fossil inside as a possible clapper. |
| 9-6-1 | LW | M | OA | 4 water worn pebbles between the head and right shoulder, hypothesized to be part of a rattle |
| 10-3 | LW | I | N-A | Mussel-shell pendant beneath left shoulder |
| 10-6-1 | LW | M | YA | At least one mussel-shell pendant as several were recovered but only one was near the neck of this individual while the rest were scattered due to rodent activity. |
| 10-10 | LW | I | N-A | One *Columella* bead at neck and an unmodified mussel shell near the waist. |
| 10-14 | LW | M | YA | A single steatite platform pipe under the left elbow, and a cut mussel-shell pendant at the neck. |
| 10-17-1 | LW | M | OA | Single cut and drilled mussel-shell pendant at the neck. |
| 12-4 | LW | F | YA | Two semilunar shell pendants at the neck |
| 12-5 | LW | F | OA | Two dog skulls mixed in with human remains |
| Knoll A-1-2 | LW | F | YA | Three drilled, semi-lunar shell pendants at the neck; 73 water-worn pebbles averaging 5 mm in diameter above the right shoulder possibly from a rattle. |

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