SILENCED VOICES: PALEODEMOGRAPHY, REPRESENTATION, AND MARGINALIZATION OF THE INDIVIDUALS AT THE BAUM SITE

by

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DEDICATION

This this is dedicated to my fiancé, Zachery. Thank you for believing in my abilities, keeping me awake to and from Greenville, and always finding a way to make me smile. I don't think this would have been possible without your unwavering support and understanding – no matter how many weekends I spent on the road. Thank you for being there when I needed you the most.

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TABLE OF CONTENTS

List of Tables vi
List of Figures vii
List of Abbreviations and/or Symbols viii
Abstract x
Chapter One: Introduction 1
Chapter Two: The Baum Site in Historical, Archaeological, and Contextual Settings 9
Chapter Three: The History of Method and Theory in Paleodemography 41
Chapter Four: Methods and Challenges of Skeletal Age-at-Death Estimations 69
Chapter Five: Materials and Methods 94
Chapter Six: Results 108
Chapter Seven: Discussion 132
Chapter Eight: Conclusion 166
Appendix 173
References 178

LIST OF TABLES

Table Page

Table 6.1. Results of analysis of the Baum Site (31CK9) Burial 1 110
Table 6.2. Burial 1 chi-square, Degrees of Freedom, and the p-value of MLNI analysis 112
Table 6.3. Results of analysis of the Baum Site (31CK9) Burial 5 ……113
Table 6.4. Burial 5 chi-square, Degrees of Freedom, and the p-value of MLNI analysis…….115
Table 6.5. Results of analysis of the Baum Site (31CK9) Burial 7…….....116
Table 6.6. Burial 7, chi-square, Degrees of Freedom, and the p-value of MLNI analysis…….117

LIST OF FIGURES

Figure: Page
Figure 2.1 “The Englishmen’s arrival in Virginia” 12
Figure 2.2 Moseley Map, 1733……..19
Figure 2.3 Charnel House, engraved by Theodor de Bry……..25
Figure 2.4 Plan view of the Baum Site and Coastal Erosion……31
Figure 6.1 Burial 1, Highest Density Region ……..111
Figure 6.2 Burial 5, Highest Density Region……...…114
Figure 6.3 Burial 7, Highest Density Region……...……117
Figure 6.4 Burial 1 Age-at-Death Distribution……120
Figure 6.5 Burial 1 Corrected Age-at-Death Estimates……...……121
Figure 6.6 Burial 1 Transition Analysis - *Os Coxae* …….……..122
Figure 6.7 Feature 1 Ossuary Age-at-Death Distribution……..……..123
Figure 6.8 Feature 1 Ossuary Transition Analysis - *Os Coxae* Analysis……..…...…124
Figure 6.9 Burial 5 Age-at-Death Distribution……125
Figure 6.10 Burial 5 Corrected Age-at-Death Estimates……126
Figure 6.11 Burial 5 Transition Analysis - *Os Coxae* Analysis..……...……..126
Figure 6.12 Burial 7 Age-at-Death Distribution……..127
Figure 6.13 Burial 7 Corrected Age-at-Death Estimates……128
Figure 6.14 Burial 7 Transition Analysis - *Os Coxae* Analysis……..…….....128
Figure 7.1 The creation of commingled assemblages…….…….146
Figure A.1 Burial 1, Highest Density Region…….…….173
Figure A.2 Burial 1, Highest Density Region……..174
Figure A.3 Burial 1, Highest Density Region……..174
Figure A.4 Burial 5, Highest Density Region……..175
Figure A.5 Burial 5, Highest Density Region……..175
Figure A.6 Burial 5, Highest Density Region……..176
Figure A.7 Burial 7, Highest Density Region……..176
Figure A.8 Burial 7, Highest Density Region……..177
Figure A.9 Burial 7, Highest Density Region……..177

Image Page
Image 2.1 Currituck County, North Carolina …….…..27
Image 2.2 Northeast region of North Carolina, with the Baum Site (31CK9) marked….28
Image 6.1 ADBOU generated matrix for Burial 1, individual “I”..... 130
Image 6.2 ADBOU generated graph for Burial 1, individual "I"……....130

Image 7.1 Plan view and topographic map of the Baum Site……..134
Image 7.2 Plan view map of the clustered burials, with shifting shoreline noted……...134
Image 7.3 Drawing of Burial 5 with bulkhead in place……...140

LIST OF ABBREVIATIONS AND SYMBOLS

HDR ..... Highest Density Region
MLNI ..... Most Likely Number of Individuals
(a) ..... alpha

ABSTRACT

SILENCED VOICES: PALEODEMOGRAPHY, REPRESENTATION, AND MARGINALIZATION OF THE INDIVIDUALS AT THE BAUM SITE

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George Mason University, 2020

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This thesis employs a paleodemographic analysis of the series of burials at the Baum Site, in Currituck County, North Carolina. Although the nature of commingled secondary burials dictates the methods that can be applied and the analyses that can be conducted, paleodemographic reconstructions are a foundation upon which interpretations can be developed. Skeletal analysis has investigated an estimated 145 adult individuals within the secondary and primary burials that compose the "cemetery" area. This estimate is based upon the burials that remained, with knowledge of significant environmental erosion or the burial contexts prior to excavation. Estimated ages ranged from subadults to individuals estimated to be in their 80's at the time of death. The data is contextualized archaeologically, and cautiously, historically. Discussion addresses the imposing power dynamic of European contact and histories, and the persistent lack of representation -

which has resulted in marginalization, a need for increased mindfulness for living-dead interactions and the power dynamics that exist.

CHAPTER ONE: INTRODUCTION

Bioarchaeology is uniquely situated to address questions and mysteries regarding the human past. Increasingly well-equipped for identifying and elucidating relationships between people and between people and their environments, method and theory has developed in an ebb and flow that defines and redefines operating frameworks. Paleodemography has not been exempt from these developments – especially when human remains emerge from a complex, commingled burial context.

The Baum Site, located in Currituck County, North Carolina, is believed to have been an Algonkian village settlement spanning from the Middle Woodland (300 B.C. – A.D. 800) and Late Woodland (A.D. 800 – 1650). Although ossuaries are historically difficult to extract information from, advances in bioarchaeological methods and applicable theory permit the reconstruction of the population through the nature and structure of the practiced funerary program. The most natural starting point for a deeper understanding is dependent upon a paleodemographic analysis. Given the complexities of a secondary burial and a history of methodological constraints, this thesis employed techniques that have been proven useful and informative in other settings when skeletal associations are not known.

In addition to the paleodemographic reconstruction, interpretative focus is placed upon frameworks that assume active roles in the construction of identity, agency, and

marginalization for the deceased, both in the past and present. Elaborated upon in a later chapter, this approach concerns the proliferation and influence of European histories that tend to portray and describe the indigenous peoples they encountered in a very biased light. Although the inhabitation of the Baum site predates European contact, later "travelers accounts" and European colonial histories set an overtone for the later treatment and marginalization of remaining indigenous upon colonization, the loss of identity that permeates modern representation, and the absence of social agency to enact change.

RESEARCH HYPOTHESIS

Drawing on Hutchinson's (2002) consideration for the need for creating a more advanced paleodemographic reconstruction of the Baum site to address a number of unresolved questions surrounding the number of individuals represented within the ossuaries, this research employed a set of techniques developed to derive the maximum amount of anthropological and demographic information from commingled human remains. This includes use of a pair matching technique that transcends the Minimum Number of Individuals (MNI) and instead offers the Most Likely Number of Individuals (MLNI). The estimated sample size is derived from how many successful pair-matches are created from a series of elements in light of how many of those independent elements are discovered. In addition to the estimation of sample size, the technique estimates the recovery probability of the contributing elements (Adams and Konigsberg, 2004). In

some instances, the recovery probabilities correlate to and provide further insight upon how much of the burial was lost to erosion. Considering excavation records that note MNI estimates for only some ossuary burials, research questions were developed to discern the validity of paleodemographic methods when applied to complex, secondary burials.

1. The application of Most Likely Number of Individuals (MLNI) protocols will result in a more robust estimate of the number of individuals within the ossuaries, as it incorporates multi-element analysis and a statistical model to estimate the original number of individuals from the recovery of elements, the number of pairs created, and the recovery probability of specific elements.

In addition to estimating the number of individuals within the burial, age-at-death estimations were established by employing transition analysis on all elements that were still scorable, even if fragmented. Transition analysis considers age-dependent morphological changes that can be observed on a series of elements, including the cranium and *os coxae*. Stages of morphological change that inform estimated age are based upon modern reference collections, with known age-at-death (Boldsen et al., 2002).

Because associations between elements were not known in most circumstances, scores from cranial suture closure and the *os coxae* were employed in an effort to establish the most robust estimates. Although more evidence tends to strengthen statistical analyses, it has been proven that the cranial scores are among the least effective age-at-death estimation tools. As such, cranial scores tend to bias point estimates (Milner and Boldsen, 2012). For this reason, point estimates are generated both with and without

cranial scores. Because age-at-death estimations have never been conducted from the remains at the Baum Site, other than the classification of subadult versus adult, the following research hypotheses emerged:

2. Age-at-death distributions of the commingled secondary burials, which are derived initially from all scorable elements and later by those derived from the *os coxae*, will provide evidence for a broad and biologically representative death assemblage. The inclusion of individuals from various ages provide further evidence for the culturally defined communal identity.
3. In addition to the archaeological evidence that informs the funerary program, the culturally redefined identity of the group, and methodological limitations, overarching biased European histories have persistently influenced the identity of the Algonkian, and the level of agency they command in death. As a byproduct, marginalization is perpetuated by a persistent invisibility of these contributing forces.

The three research hypotheses direct and outline the paleodemographic foundation upon which further analysis may occur. While the present chapter introduces and outlines the primary goals of this thesis, later chapters elaborate upon the methods employed. Furthermore, various theoretical applications that increase understanding are considered in conjunction with the burials and associated individuals, as they exist archaeologically, through the Middle and Late Woodland, historically, and today.

ORGANIZATION OF THE THESIS

Expanding upon the topics introduced in this chapter, Chapter 2 introduces the history and archaeological context of the Baum site. Spanning in use from the Middle to Late Woodland, the overlapping spatial distribution sheds light on cultural manifestations over time. In addition, histories of European contact and interaction with the Algonkian are introduced – including recorded accounts from the earliest point of contact, to the later creation of a reservation. Although Thomas Harriot and John White were the point of origin for many contact histories, Theodor de Bry played an active role in the proliferation of histories by recreating media based upon original artwork and descriptions. Notable to the bioarchaeological nature of this thesis, Harriot observed and made note of the Algonkian mortuary program. John Lawson's later histories provided a potentially informative survey of regional indigenous tribes and their respective hunting patterns. Shifting focus to modern records, accounts of archaeological excavations at the Baum Site are presented in a fashion that draws special attention to worsening erosion, the spatial distribution of the burials, and the artifacts and features that were associated with each burial. Lastly, a review of literature involving past research at the Baum Site are briefly introduced.

Having established a sound contextual foundation of the Baum Site itself, Chapter 3 introduces the broader concepts and goals of paleodemography in bioarchaeology. To lay the groundwork for the burial estimates established by MLNI, this chapter describes early foundations in zooarchaeological studies. In addition, the history

of the optimistic rise of paleodemography, - the supposed death of the field, and its reemergence involving attempts at conceptual and theoretical rapprochement are reviewed. The critique and discussion that resulted in a reformation of paleodemography is important to address, as it sets the precedent for the necessity and utility of contemporary paleodemography in bioarchaeological studies. Specific to the research presented in this thesis, paleodemographic origins of sample size estimation and applicability of applying the Most Likely Number of Individuals (MLNI) for commingled remains are reviewed.

Chapter 4 dives into the methods of age-at-death estimations from human skeletal remains. Long situated as an important locus for new, groundbreaking approaches in human skeletal analysis, age-at-death estimations exist as an important and foundational component of any bioarchaeological study. In order to address and understand the persistent challenges, the development of methods and associated limitations are addressed in chronological fashion, beginning with work from the early 20th century to today. Finally, transition analysis and its utility for commingled remains are introduced. Considering its value to complex burials, the applicability and accuracy of transition analysis is demonstrated through a series of case studies.

Chapter 5 presents the materials and methods used in this work. Special focus is placed upon the technical application of MLNI and transition analysis, including both the mathematical foundations of the method and web-based applications. Specifically, MLNI was computed and visually represented with open-access R scripts. Transition analysis

employed ADBOU, which is a software platform developed with pre-existing reference collection data already included.

Chapter 6 introduces the results of the analyses described in Chapter 5. Beginning with the presentation of MLNI data, Burial 1 produced results with an estimation of sample size that is on par with previous MNI estimates. Burial 5 and Burial 7 produced results that were not within the Highest Density Region (HDR) that were closest to the 95% confidence interval range. The statistically significant relationships therein show it is likely that the calculated ranges were too narrow to accurately estimate the number of individuals within the ossuaries. Despite evidence to support the ranges were too narrow, the recovery probability of the individual elements reflects the impact of erosion of the burial. Results from transition analysis were based on all scorable elements, age-at-death distributions were gathered from Burial 1, Feature 1 Ossuary, Burial 5, and Burial 7. Although the number of individuals within the age range distribution varies, each burial exhibits a pattern that includes both the young and the old. In addition, age-at-death estimates were more narrowed when cranial scores were removed.

Chapter 7 interprets the biocultural significance of the results presented in Chapter 6. Beginning with an analysis of the various types of commingled burials that exist, the Baum site is analyzed with the characteristics that typify ossuaries. An expansion of this analysis offers insight to the symbolic meaning of a “cemetery” and the sacred space created by the deposition of ancestors. Finally, the paleodemographic data are incorporated with the extant archaeological record to elucidate symbolic meaning between the individual and the group. Considering the interpretations, discussion turns

about to the influence of European histories, and the overarching frameworks that impact conceptualizations of the collective identity, agency, and continued marginalization of the deceased today.

CONCLUSION

This bioarchaeological analysis of the Baum Site produces a paleodemographic reconstruction that estimates the number of individuals represented within each burial, and the associated age-at-death estimates. As a foundation to many bioarchaeological investigations, completion of this task addresses previously unresolved questions but is also meant to encourage further analyses. In addition, the attention given to various overarching structures and subsequent conceptualizations of identity, agency, and marginalization are meant to make this issue visible within bioarchaeology, those who utilize and depend on historical contingencies, and the broader spectrum of people who may not realize deep-rooted bias and manifested marginalization.

CHAPTER TWO: THE BAUM SITE IN HISTORICAL, ARCHAEOLOGICAL, AND CONTEXTUAL SETTINGS

The historical and cultural conceptualizations of North Carolina Algonkian settlements have been deeply influenced by the written records produced by European explorers during the Early Contact period. Archaeological evidence from the region has corroborated some lines of historical data. In even an even more glaring fashion, historical documents tend to misrepresent Algonkian peoples to promote the viewpoints of the Euroamerican colonizers.

For instance, indigenous peoples have received general labels such as North American and North Carolina Algonkian, which has resulted in broad misrepresentation as a "tribe," rather than the broader and much more inclusive spectrum of peoples and identities that the name encompasses. Rather, the term Algonkian refers to a language and cultural family within which numerous named tribal populations resided. "Algonkian" is an adapted term from the original Algonkin tribe of Canada that can more generally be understood as a linguistic family that arguably spanned a larger area than any other in North America (Hodge, 1907). In many histories, the names of tribes, if not recorded or changed in European contact histories, have been replaced with the broad "Algonkian tribe" descriptor. Although this has been an accepted anthropological term for these series of tribes, it should be noted that the significant negligence is apparent in preserving original tribal names. This negligence lent itself to identity erasure at the

hands of European misperception, misunderstanding, and censorship was also inevitable. In usage today, this loss of identity arguably has even greater impacts on the disparity of Algonkian tribes and empowered representation within the state (North Carolina Tribal Communities, 2020).

In the wake of European colonization, the land that once hosted the final resting place for Algonkian peoples passed through multiple generations of the Baum family. Used as housing property and for small operation farming practices, the land commonly produced prehistoric and historic artifacts worked to the surface through tilling and coastal erosion – which often occurs on the coast, especially when powerful hurricanes develop (Phelps, 1980). Over time, however, the Algonkian burial site now known as the Baum Site, or 31CK9 at the North Carolina Office of State Archaeology, burst into the public sphere once human remains began to appear on the beach, erode out of embankments, or appear at the surface. Out of respect for the burials and the individuals that comprised them, the family notified local archaeologists at East Carolina University for immediate consultation and their eventual salvage (Phelps, 1980). This chapter provides the contextual foundations for the study of the human remains described in this thesis and provides an overview of the history and archaeological characterization of the Baum site and its place in the broader Algonkian world.

THE PROLIFERATION OF EUROCENTRIC HISTORIES

Although the use of the Baum Site as a location of settlement and burial dates to an era before European contact, there is an overarching point that can be made between the histories and modern understanding of the Algonkian settlements. Despite the historical text's continued use as a primary tool in which data can be analyzed and contextualized, there is an acknowledgement of information lost at the hands of Euro-centric bias. Evidence for such efforts are brought to light in famous and well circulated texts that resulted from contact. Descriptive in nature but far from presenting a comprehensive understanding, the texts and images are saturated by overtones of Western ideologies and are reflective of a colonizing entity - portraying the indigenous peoples as something they are not, critiquing and dismissive of their belief systems, and generalizing aspects of culture in large scope. At best, the portrayal of the encountered indigenous in European histories depend on production. This results in a shallow understanding of the people, and effectively dismisses an attempt at understanding identity.

In the midst of the awe-inspiring descriptions of the newly discovered land, Arthur Barlowe, a captain on the Amadas expedition, wrote to Sir Walter Raleigh concerning the interactions with the Secotan. The texts were sent on behalf of the exploring company, including William Greenvile, John Wood, James Browewich, Henry Greene, Benjamin Wood, Simon Ferdinando, Nicholas Petman, John Hewes, and Philip Amadas. Although historic texts locate the Secotan south of the Baum Site, the Secotan were similarly an Algonkian-speaking population (Quinn, 1955). Writing in a manner

that exudes excitement for the positive interaction with indigenous populations, the letter conveys a sense of two-way bewilderment for the "whiteness of our skins, ever coveting to touch our breasts" (Barlowe, 1584, pg. 9). Similar admiration was supposedly extended to the grandiose ship that brought the explorers, and the creation of boats by the Secotan that could hold up to twenty men.

Figure 2.1. "The Englishmen's arrival in Virginia" by Theodor de Bry and John White, 1590. Digitized by the Library of Congress.

Praising the Secotan in dress, commodities, and loyalty to what the explorers viewed as the king, the Secotans nevertheless had a "mortall malice" with neighboring

settlements, such as the country of Pomouik, led by Piamacum. These settlements, whose locations are described as generally westward ("towards the setting of the Sunne"), around the "goodly river called Neus," (now known as the Neuse River), were later remedied by an agreement of peace (Barlowe, 1584, pg. 10). Despite the supposed peace, the malice embodied by the Secotan were rooted deeply in previous attacks by Piemacum, after having invited the Secotan to enter their respective territory. During one such visit, the Lord of the Pomouik attacked, sparing only women and children. In describing the attack, Barlowe elaborates the event with descriptions of the practiced religion, stating that "they were altogether merry, & praying before their Idoll, which is nothing els but a meer illusion of the devill" (Barlowe, 1584, pg. 10). The good nature of the Secotan, therefore, was debated and left to "tryall hereafter," as a true "love they beare to us," or as a tactic for protection from the Pomouik (Barlowe, 1594, pg. 10).

Thomas Harriot reinforced such sentiments. His 1585 exploration report depicted the idol Kivvasa in a crouched position, adorned with beads of copper, "which they esteeme more than golde or siluer," the wooden carving is described as standing at four feet in height. The face, "like the heades of the people of Florida," was painted in a skin tone similar to the worshipers, while the chest was white, and the rest of the body black, with the exception of white sputters on the thighs. Sitting in the corner of the temples, known as Mathicómuck, the idol Kivvasa (Kewás in Harriot's records) was venerated as the keeper of the King's corpses. Having viewed the explorers pray, Harriot noted that they began to move their mouths in a prayer-like manner. Given their supposed quick ascription to the Western religious practice of spoken prayer, Harriot believed "them

verye Desirous to know the truthe" and "might easelye be brongt to the knowledge of the gospel" (Harriot, 1585, pg. 63). In addition to the held belief that the Secotan were redeemable through conversion, given the perceived attempts to mimic the explorers and their preconceived notion of an afterlife that tacitly resembled the Christian Heaven and Hell, he questioned the likelihood that their religious origin truths could be kept sacred without having letters or means to keep records (Harriot, 1585).

Working from the watercolors that were produced from John White, Theodor de Bry's produced engravings that were meant to reach the masses. Produced in Frankfurt in 1590, the engravings and the descriptions were printed in English, French, German and Latin. Twice-removed from White's personal contact with the indigenous, the engravings were produced to showcase the discoveries of the New World. Today, the engravings have been digitized and made available by the University of North Carolina Chapel Hill. They are accompanied by anthropologically-minded statements that warn against the unquestioned use and interpretation of indigenous peoples as they were portrayed in the engravings. Comments accompanying the digital files state that de Bry made significant changes to White's original watercolors, including the alteration of the facial structure to more closely resemble Europeans and the application of musculature that more closely reflect classical statues (de Bry, 1590; North Carolina Collection, University of North Carolina Chapel Hill, 2006). These acknowledgements accompany a statement that warns viewers to acknowledge the inherent bias of the artist, perceptions that are Eurocentric, and an unwillingness to understand the differences between European and Native American culture.

Descriptions of ideologies held by the indigenous textualized by European records carry significant overtones of Western ideas of what religion was supposed to look like in practice. The descriptions that compare the Secotan idol to a devilish figure, and the recurring assurances that conversion was possible and even imminent, provides further evidence for the staunch ethnocentrism that accompanied the colonizer mindset.

In addition to sensational descriptions of the appearance of the encountered peoples, their dress and stock of commodities, Barlowe finalizes the letter with "we brought home also two of the Savages being lustie men, whose names are Wanchese and Manteo" (Barlowe, 1584, pg. 12). This was the first and last mention of a traveling duo in the Old South Leaflets, titled "The First Voyage to Roanoke. 1584."

Although Barlowe acknowledges that Wanchese and Manteo traveled to England for the purpose of educating Thomas Harriot on Algonkian language and culture, a full understanding of what transpired while in England has been lost to history. What is known of their return to North America has been shadowed by the disconnect the two shared upon their return home in 1585 on the second expedition funded by Raleigh. It was at this point that their paths forked - Manteo continued to aid the travelers in solidifying relationships between the indigenous and the explorers, and then disappeared from historical records after the Roanoke colony failed. Conversely, Wanchese returned to the Roanoke region with a renewed wariness and unwillingness to continue to provide aid to the ever-encroaching English. Severance of his ties with the English was reflected in the historical records (Vaughan, 2002).

ORIGINAL INHABITATION

Although the evidence of the initial peopling of eastern of North America dates to the Paleoindian Period between 11,000 to 8,000 B.C. (although some contest an ephemeral human presence around 13,000 B.C. (Daniels, 2002)), the earliest evidence of human occupation of the Baum Site has been dated to the Middle and Late Woodland, 300 B.C. to A.D. 800 and A.D. 800 to 1650 respectively (Daniel, 2002; Ward and Davis, 1999). Geographically speaking, Woodland Period occupations are divided into regional zones that are demarcated by language and cultural affiliation. The northernmost portion of the Coastal Plain is divided into two zones: the inner and outer coastal plains. The Algonkian peoples inhabited the outer coastal plain, while the Tuscarora people inhabited the inner coastal plain. The southern coastal plain was inhabited by the Siouan (Daniel, 2002).

Precontact regional culture has been primarily focused on the Middle Woodland (300 B.C. – A.D. 800) and the Late Woodland (A.D. 800 - 1650) in the northern coastal plain (inner coast) and the northern coast (outer coast). The Middle Woodland corresponds to Mount Pleasant phase sites, which are identified by distinguishable pottery. In appearance, this pottery is tempered with sand and particles that are roughly the size of pebbles. The pottery is often fabric impressed, cordmarked, net impressed or smoothed (Hutchinson, 2002; Ward and Davis, 1999).

Middle Woodland period sites tended to center on streams and estuaries, indicating a dependence on aquatic resources for subsistence. Although shellfish and fish

bones appear in the archaeological context in impressive middens, remains of deer, racoon, rabbit, turtle, and turkey have also been discovered (Phelps, 1983). Based on the scope of archaeological remains associated with the Middle Woodland, these sites are interpreted as early locations of permanent settlement with possible seasonal movement towards the coast for resources (Hutchinson, 2002; Ward and Davis, 1999).

The Late Woodland began the shift in culture and language characteristics to that which European explorers observed during contact, as delineated by both location and time. For instance, peoples with Algonkian linguistic and cultural ties during the Late Woodland created pottery that was tempered with shell (Hutchinson, 2002; Ward and Davis, 1999). Other Colington phase associated items include ceramics with surfaces that are fabric impressed, simple stamped, smooth, or incised (Hutchinson, 2002; Phelps, 1983; Ward and Davis, 1999). Comparatively, the Cashie Phase from the inner coastal plain were reminiscent of the Middle Woodland Mount Pleasant Phase. In addition to the fabric impressed, simple, and stamped surface decoration, the rims of the vessels were pinched (Ward and Davis, 1999; Hutchinson, 2002).

The permanent villages of the outer coastal Late Woodland include long houses and are sometimes surrounded by vertical wood palisades, as evidenced by post molds encountered during excavation in Hyde county (Hutchinson, 2002; Gardner, 1990). This type of structure was reflected in drawings created by European explorers of a palisade at the village of Pomeiock (White, 1585; De Bry, 1590).

Ample evidence of subsistence patterns exists in ethnohistoric records and archaeologically. John Lawson’s survey in 1709 suggested that settlements along the

coast had plentiful hunting patterns, and a wide variety of land food resources that included black bear, venison, cucumbers, and melons, just to name a few (Lawson, 1909; Hutchinson, 2002). In fact, By the time Harriot (1590) and Lawson (1709) began to independently produce ethnohistories, they described rank societies with maize plots and food processing – an early description of agricultural transition in the Late Woodland.

Although not a diagnostic tool for determining the transition to agriculture, carbonized food remains in hearths provide evidence for the harvest and subsequent processing of domesticated food plants (Bar-Yosef and Meadow, 1995; Hutchinson, 2002). There is no archaeological evidence for maize agriculture in the inner and outer coast until 800 A.D., when the Tuscarora emerged in the coastal plains. Even between 800 A.D. and 1400 A.D., there is very little evidence of maize agriculture, in either food remnants or stone farming tools, on the inner and outer coast suggests that it did not become a staple in diet as quickly as Mississippian settlements (Larsen et al., 1991; Hutchinson, 2002).

It has been suggested that agriculture did not emerge in the inner and outer coastal areas until 1300 – 1400 A.D., after the Little Ice Age. Although no geological data can confirm the extent by which the climate and coast changed**,** Green (1984) suggests that the previously warmer climate might have focused high salinity dependent resources in certain pockets of the inlets. This suggestion is made in light of the known impacts occurring in Europe, at the same time. Cooler temperatures would have increased the overall salinity of the water and extended these resources to a much wider area, although it might have also inhibited mobility (Green, 1984). The shift to agriculture,

sociopolitical organization, and economic changes appear to have been an adaptation to the changing climate, and thus access to resources (Hutchinson, 2002).

Initially distinguished via linguistic variation by early cultural anthropologists, such as Speck (1924), inner and outer coastal groups have further been divided through a comparative archaeological analysis of burial types. The Algonkian nation of the outer coast tended to create larger ossuaries, incorporating more individuals that those in a single-family unit. In some cases, this included dense and overlapping secondary burials. Conversely, the Iroquoian nation peoples of the inner coast tended to have smaller scale burials, likened to family plots (Hutchinson, 2002; Loftfield, 1990; Mathis, 1997; Truesdell, 1995).

Figure 2.2. Moseley Map, 1733 (Theodor de Bry, 1590; North Carolina Collection, Digitized by the University of North Carolina Chapel Hill, 2006).

There are several named tribes in the immediate vicinity to the Baum Site whose names at least have been preserved. Based upon the famous map of North Carolina drawn by Edward Moseley in 1733, the two closest inhabitant groups that dominated the western bank of the Currituck Sound are recorded as the "Yawpim" and "Potoskite" Maps noted that the area west of the Currituck Sound was home to the Algonkian-language speaking Weapemeoc tribe, which had named settlements outside of the principal settlement (Moseley,1733). The transcription "Yawpim" on the 1733 Moseley map is believed to correspond to today's known "Yeopin" terminology, an abbreviated term for the Weapemeoc tribe (Mook, 1944).

It has been estimated that the Yeopin's numbers dwindled to 200 by the mid-18th century. Pasquotank county records, which were created by Robert Morgan for review by the Provincial Assembly, reflect the dynamic relationships between the remaining Yeopin and local residences. Some relationships between the Yeopin and Euroamerican settlers were described as honest and tactful. Conversely, there were instances of trickery, dishonesty, and enslavement of Yeopin. Yeopin retaliation often resulted with theft. As a result of the strained relationship, the Yeopin received 10,240 acres, approximately sixteen square miles, for tribal use by the Executive Council in 1704. It was later decided that tracts of this land could be sold at will, and for compensation (Pugh, 1957; Phelps, 1984; Cross; 1983). By the time the Yeopin departed Eastern North Carolina in 1774 for New York, it is likely that only a few thousand acres remained under Yeopin jurisdiction. Morgan reports that upon abandonment the land "fortunately" supplied the surrounding

area with plenty of wildlife resources. In addition, the Yeopin left behind a delectable recipe for preparing fish over aromatic wood (Pugh, 1957). The 1733 Moseley map also records a “Potoskite” settlement, which is relatively close to the location of the Baum archaeological site. It was recorded in 1711 that there were approximately 70 to 80 in this settlement. This number dwindled to approximately 20 families by 1731 (Mook, 1944).

As reported widely in historical documents, the Weapemeoc inhabited what is today Camden, Perquimans, Pasquotank, and Currituck Counties (Pugh, 1957). The Weapemeoc’s western neighbors were the Chowanoac tribe, which expanded across modern-day Gates, Hertford, Bertie and Chowan Counties (Johnson, 1972). Although focused primarily on sites near the Currituck Sound, Image 2.2 identifies and marks some of these discovered archaeological sites (Phelps, 1980).

EUROPEAN CONTACT AND EARLY ACCOUNTS OF ALGONKIAN CULTURE

Beginning in the 16th century, Eastern North Carolina became a location punctuated by bouts of European contact. Prolonged interaction with the native peoples emerged once permanent colonization efforts began. Regionally speaking, Spanish contact with the Siouan was first made by the Lucas Vasquez de Allyon expeditions in 1521, 1524, and 1526. During the final expedition, de Allyon landed near the Cape Fear River, but quickly moved north. Impeded by disease that eventually killed de Allyon, the settlement San Miguel de Guandape was abandoned near present day Shackleford Banks.

The wild horses that roam the island today are believed to be the descendants of those abandoned by the Spanish (Powell, 1989).

Although the De Soto Expedition of 1539-1543 also landed near the Cape Fear River and the Siouan region, their travels extended west and resulted in contact with indigenous peoples at Chalague, Guaquili, and Joara. These settlements are near present day Charlotte, Hickory, and Morganton, North Carolina respectively. Bent on discovering valuable resources, de Soto had an especially explosive confrontation with the Joara, as records indicate he held individuals from this settlement hostage and tortured them for information about mineral deposits. Eventually, De Soto and his crew moved further west into Tennessee by following the French Broad River, the Nolichucky River, and the Toe River. De Soto's expedition made it as far as the Mississippi River, where he fell ill and died from malaria. Reports indicate De Soto died on the riverbank with no gold, no silver, and only a few freshwater pearls to mark the grand sum of riches gathered along the way (Hudson, 2005; Merrill, 1989; Powell, 1989; Vigneras, 1969).

The earliest recorded European contact with the Algonkian culture occurred in 1584 when Captain Philip Amadas began to search for suitable land to establish a colony (Quinn, 1955) Accompanied by John White and Thomas Harriot, the group initially landed on the Outer Banks but were guided through an inlet of the Roanoke Island by Algonkian natives (Quinn, 1955).

White and Harriot were tasked with studying the people they encountered to better prepare for future expeditions and the interactions that would have to occur during settlement. This task included recording the language, mapping the inhabited region, and

drawing the people and their customs. This work continued even after leaving North America, when two native people, Wanchese and Manteo accompanied the crew on the return trip to Europe. Wanchese and Manteo, returned to their home on the second expedition to the region (Moran, 2007), which was launched in April of 1585. In addition to Wanchese and Manteo, this group included a population of around 600 colonists and military crew – the components of a permanent colonizing force. Once again, Harriot and White were tasked with documenting encounters with indigenous peoples. The intention to port near the location of the original expedition was thwarted by weather-related navigational issues. Despite having the foreknowledge of the land and inhabitants, the second expedition was later considered a failure by the stakeholders in England. The expedition resulted in a fatal altercation between the soldiers and indigenous inhabitants, and the inability for European colonists to reside in the unfamiliar and harsh New World came into focus (Quinn, 1955).

Historical Records of Algonkian Mortuary Culture

Later, a series of sequential expeditions resulted in an abundance of famous, albeit idealized illustrations of Algonkian culture – sensationalized and presumptive characterizations the "other" (Quinn, 1955) Consistent with the creation of the ossuaries that are indicative of the Algonkian mortuary culture - and the processes that likely resulted in the creation of the Baum Site itself - Thomas Harriot described a charnel house most likely belonging to the Secotan. Used to process the deceased, it was depicted

as having an internal scaffolding that was nine or ten feet high. Harriot describes the processing techniques practiced by the coastal Algonkian, as such:

> first the bowells are taken forthe The layinge downe the skinne, they cutt all the flesh cleane from the bones, which the drye in the sonne, and well dryed the inclose in Matts, and place at their feete. Then their bones (remaininge still fastened together with the ligaments whole and vncorrupted) are couered a gayne with leather, and their carcase fashioned as yf their flesh wear not taken away. They lapp eache corps in his owne skinne after the same in thus handled, and lay yt in his order by the corpses of the other cheef lordes. By the dead bodies they sett their Idol Kiwasa, wher of we spake in the former chapiter: For they are persuaded that the same doth kepe the dead bodyes of their cheef lordes that nothinge may hurt them. Moreouer vnder the foresaid scaffolde some of their preists hath his lodginge, which Mumbleth his payers nighte and day, and hath charge of the corpses. For his bedd he hath two deares skinnes spredd on the grownde, yf the wether bee cold hee maketh a fyre to warme by withal (Harriot 1585, page 64).

Figure 2.3. Charnel House, engraved by Theodor de Bry based on the accounts of Thomas Harriot in a Travel Diary, 1590 (Theodor de Bry, 1590; North Carolina Collection, Digitized by the University of North Carolina Chapel Hill, 2006).

Historical accounts unsurprisingly contrast and conflict to varying degrees with archaeological discoveries. A prime example of this is the disconnect between the 1585 description of the charnel house, the 1590 de Bry narrative, and direct archaeological evidence. The description provided by Thomas Harriot resulted in de Bry's depiction, which suggested the circular structure to have large pointed posts, with at least a few feet between each post. Archaeologically, the site believed to correspond to the depiction of the posts are no more than a few inches apart and outline a rectangular structure. In either scenario, the posts would have been lashed together with smaller horizontal supports that would have provided stabilization – much like the scaffolding described by Harriot. The

roofing structure and siding, interpreted as an adaptation to the hostile coastal environment, likely would have been covered with woven red reed mats. It has been estimated that the charnel house depicted by Harriot could have occupied anywhere from 40 to 60 individuals, ranging in age and size. The length of processing time an individual would have received has also been debated, considering the co-existence of completely disarticulated bundled bones that likely had a lengthy processing term and burial taphonomy that suggest some level of articulation (Daniel, 2002).

ARCHAEOLOGICAL EXCAVATION

The Baum Site is located just west of the Currituck Sound in Currituck County, North Carolina. The earliest indication of a culturally significant archaeological site was discovered during a routine survey conducted in 1955 – 1956 by William Haag. That survey documented eight archaeological sites in Currituck county – four near Waterlily (an area within Poplar Branch), and four located closer to the southern point of the peninsula. At that time, the five-acre Baum Site is situated north of a forested swamp that serves as a tributary emptying into the Currituck Sound. Specifically, the site is situated north of a forested swamp that serves as a tributary emptying into the Currituck Sound. The northern boundary includes a canal that was created to drain a farm pond, situated on the western border of the site. At the time of discovery, the archaeological site was undisturbed and did not show significant damage due to erosion. The site was then left

undisturbed until 1972 when an archaeological survey and excavation was conducted by East Carolina University (Phelps, 1980).

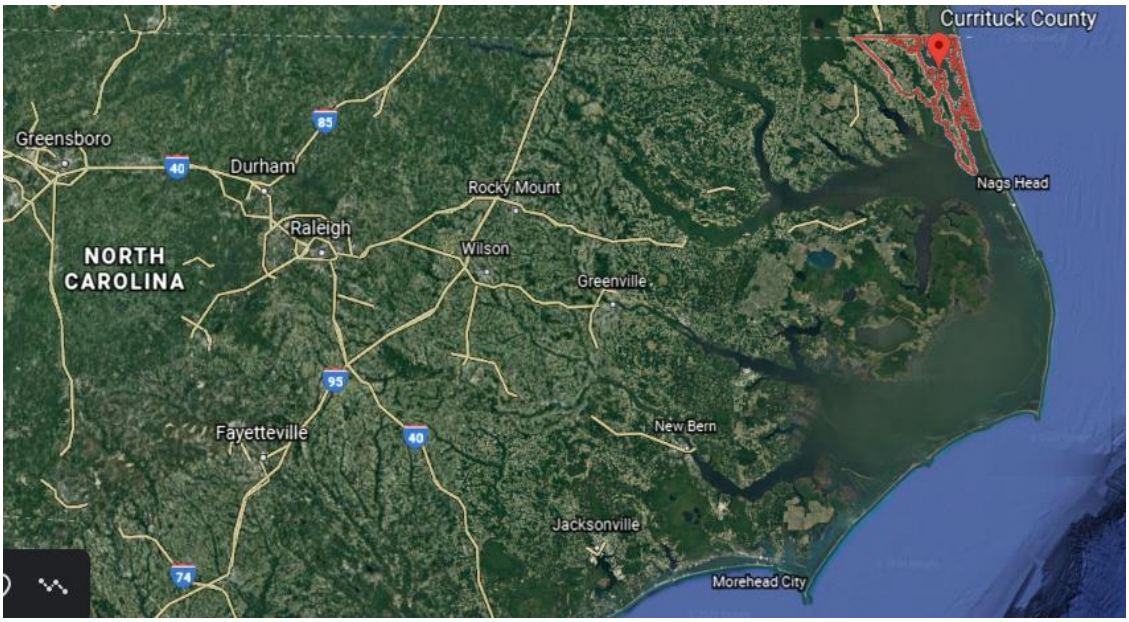

Image 2.1 Currituck County, North Carolina.

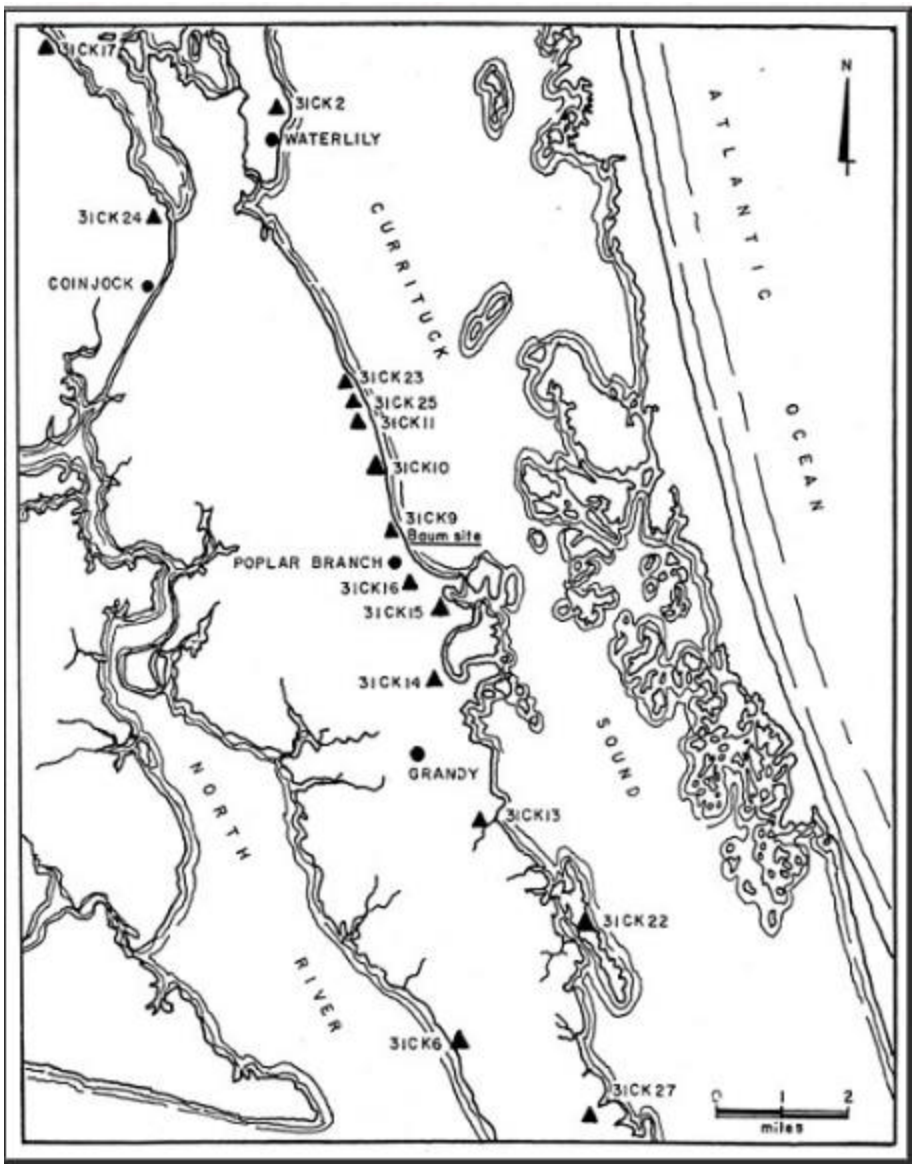

Image 2.2 Northeast region of North Carolina, with the Baum Site (31CK9) marked.

At that time, the landowners reported that human bone was eroding from the side of the riverbank. To salvage what remained, East Carolina University began to record and excavate the site. Led by Dr. David Phelps, cultural features and a portion of an Algonkian ossuary were revealed. This primary excavation offered insight on the

importance and relative frequency and distribution of the cultural occupation in the area., which prompted the need for further research. The project's research questions addressed the stratigraphy and sequence of human occupation at the site, the nature and scope of cultural features and artifactual records, and surface topography. Surface topography specifically addressed the impacts of erosion on the site, and thus indirectly informed also the distribution of the cemetery site as erosion persisted. Initial test units in 1973 discovered the first primary burial near to the later-excavated Burial 1 ossuary. Due to time and funding constraints, the burial was left *in situ.* It was excavated in 1974, and the production of burial maps placed this discovery adjacent to the Burial 1 ossuary (Phelps, 1980).

At the time of publication for the 1972 survey, the authors became increasingly aware of the of the erosion-related risks from sea level rise, and the effects of agricultural plowing on the site. High winds and storm surges threatened human remains already eroding from the bank and it was reported that the site sat a mere four feet above the sea levels during normal tidal flows (Phelps, 1980).

Phelps sought to track the swiftly changing sea level after the 1972 excavation. Control markers that were placed in 1973 were lost due to erosion in 1980. Although it appears that current environmental factors accelerated the erosion process, it was estimated that over 1000 feet of shoreline has been lost since the original occupation – resulting in a need to rethink the interpretation of the Baum Site as a "cemetery" on the outskirts of a settlement. Because it is unknown how much shoreline was lost, the size

and placement of the burials in relation to the settlement might have been eroded before it could be documented (Phelps, 1980).

Although there is some evidence for occupation prior to 300 B.C., it has been estimated that focus on human activity at the Baum Site began in the Middle Woodland (300 B.C. to A.D. 800) and progressed into the Late Woodland (800-1650). Ceramic remains from the Baum Site of the Middle Woodland period are regionally included in the Mount Pleasant phase. Broadly categorized, these ceramics are identifiable by sand and pebble temper (Phelps, 1980). The abundance and dispersal of Mount Pleasant ceramics indicate the use of the location as a functioning village site, although no evidence of any structure was found. In addition, two Middle Woodland period flexed burials were found – Burial 3 as a primary burial, and Burial 2 as a primary cremation. The juncus mat associated with the cremation, which may have been before or around the time of creation, was radiometrically dated to A.D. 360 +/- 65 years (Phelps, 1980).

Later occupation at the site, consisting temporally recognizable ossuary burials, dates to the Colington phase of the Late Woodland period which encompasses the pre- and protohistoric culture of the coastal Algonkian peoples (ca., 1584 – 1587). Evidence of Late Woodland period persistent occupation include the Colington ceramic vessels, Roanoke projectile points, lithic and bone tools common in the region, and beads and milling stones (Phelps, 1980).

The Baum Site also contained ossuaries, one of the most recognized cultural practices of the Algonkian. The practice of such large collective secondary burials was common throughout the Middle Atlantic during the Late Woodland. At the time of

Phelps's 1980 site report, there were three discovered ossuary burials, with a series of primary burials and primary cremations associated with Burial 2, Burial 3, and Burial 4. What became known as Feature 1 Ossuary "was observed only as the remaining pit bottom with some charred and uncharted human bone still in place on the beach in 1972" (Phelps, 1980, pg. 7).

The second ossuary that was documented, designated as Burial 1, was also discovered during the course of test excavations in 1972 but was excavated the following year. Excavations revealed the secondary burial contained at least 58 individuals, including eight individuals that were either articulated or processed and subsequently bundled. Although unusual for ossuary contexts, Burial 1 included grave goods including: a panther mask, bone awls, and bone pins (Phelps, 1980).

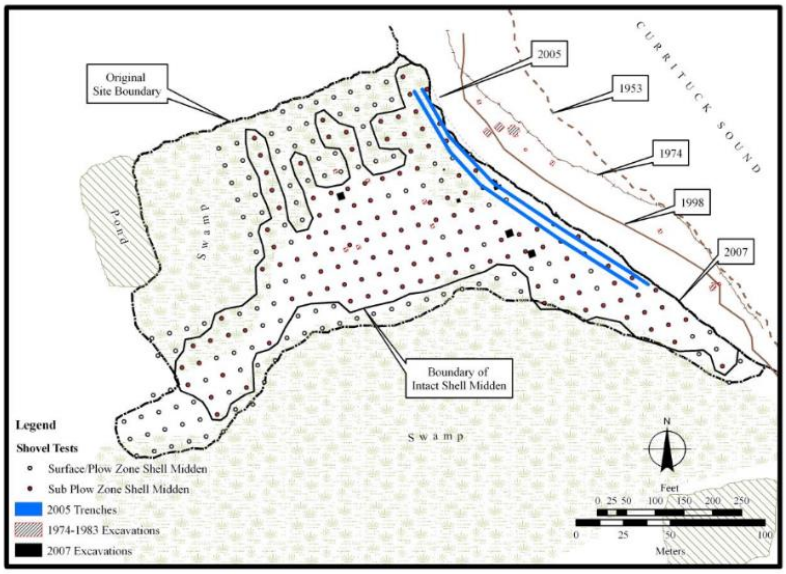

Figure 2.4. Plan View of the Baum Site and Coastal Erosion (Ewen et al., 2011).

Phelps's report does not elaborate on the funerary contexts discovered between Burial 1 and Burial 5 (e.g., Burial 2, 3, and 4). Despite this omission of other known burials, Burial 5 is described in detail in an excavation report. Discovered as a result of erosion in May of 1980, efforts were made to preserve the burial while funds for excavation could be secured. In the meantime, the context was protected by plywood and soil fill. By June of 1980, storms had washed away the temporary cover and more bone was exposed. In response, remains that were washed away from their original location gathered from the beach. In a secondary attempt to protect the ossuary, the eroded border was protected by a temporary bulkhead, comprised of boards affixed to posts. The eroded boundary provided allowed the researchers to assume an outer boundary of 4 x 4 meters (equivalent in records to squares Q-T). This boundary provided enough space for the pit, and a working platform. Initial excavations removed the plow zone, in order to establish the boundary of the burial pit in terms of its horizontal stratigraphy. Rather than continuing these preliminary excavations, the exposed pit was covered in plastic tarp and backfilled. Initial impressions of the burial pit include an estimated minimum number of individuals ranging between 20 and 40 individuals (Phelps, 1980).

Formal excavations of Burial 5 began with the removal of the backfill that covered the tarped units were removed, and Zone I, corresponding to "plowed, disturbed upper soil from Squares S and T" were excavated (Phelps, 1980, pg. 8). A profile of the ossuary pit was created by examination of the previously eroded barrier, and the boundaries were plotted and photographed when it was determined that sterile subsoil was encountered. The first articulated skeleton was discovered only two centimeters

below the surface of the fill. In order to maintain the provenience of the remains, a 1-meter grid was created and divided into 8 sections (Phelps, 1980).

Articulated remains were cleaned, identified, and grouped in removal as not to confuse individuation. Otherwise, commingled remains were gathered and labeled in accordance to the previously plotted sections. Such excavation methods were employed until the bottom-most layer of the pit was discovered. To prevent the loss of small elements, the bottom fill was wet screened. The Minimum Number of Individuals was estimated at thirty based on the number of crania encountered. The excavation of Burial 5 began on July 12 and concluded only seven days later (Phelps, 1980).

Further archaeological excavations occurred in 2005 and 2007 in order to assess the change of the coastal landscape and resulting in the loss of the site in preparation for development after the land was sold by the Baum family. Two separate evaluations of the site were conducted in 2005. One excavation project explored reports of human bone once again eroding from the bluff. These remains were excavated in October of 2005 (Terrestrial and Underwater Archaeological Survey, 2012). The other survey to document landscape changes since David Phelps's original excavations discovered a midden in close proximity to a trench dug by a backhoe. The midden's upper levels were excavated by hand and mapped with a more recent datum point, since Dr. Phelps's 1983 datum was lost to erosion (Ewen et al., 2011; Lautzenheiser and Stewart, 2006).

The survey in 2007 were similarly motivated to reevaluate changes to the landscape for future land development. In the two years between surveys, the datum point suggested that five to ten feet of land had eroded. As outlined in Figure 2.4, this is

significant loss when compared to the earliest established boundaries of the site (Ewen et al., 2011).

INTERPRETATIONS OF THE BAUM SITE

There are eight documented burials at the Baum Site, all representing a range of burial types, including ossuary, primary cremation, and single and multiple burials. The data gathered and employed in this study are from the Middle Woodland and Late Woodland. Notably, Burial 2 and Burial 3, which overlap one another, have been radiocarbon dated using a portion of juncus mat placed within the burial.

Ossuaries have a known and long-studied cultural use within the Algonkian speaking nations, and within the Eastern North Carolina geographic region. An early study identifying ossuaries within the region was supplied by Frank Speck, although he did not include the Baum Site likely because the date of his work was far before the dynamic nature of the North Carolina coastline began to erode the ossuaries on the privately owned land of the Baum family. Regardless, Speck (1924)'s classic work provided an impressive history and interpretation of Algonkian migration throughout North Carolina using historical documents, linked linguistic families, mortuary program, and traced cultural interrelationships.

Speck's interpretation of behavior was based upon the overt linguistic similarities, despite some evidence for regional dialect variation and recorded discrepancies between cultural practices. In addition to demarcating linguistic families, Speck describes the

names of each sub-group and roughly outlines known areas of habitation - drawing heavily from texts written by explorers such as those provided by John White. An understanding of contact and social complexity, including the interpretation of shared complexity with more southern settlements is supported by ethnohistorical accounts and archaeological remains. Speck suggested that a southern migration of culturally similar groups occurred as an organized byproduct of perhaps war-like circumstances or environmental constraints that promoted the establishment of new areas of habitation (Speck, 1924). Further analyses of geographic relationships, cross-cultural comparisons of social practices, logistics of ossuary burials, regional contexts of tribal land, and the paleopathology of the skeletal remains have been considered by Hutchinson (2006), Loftfield (1990), Hutchinson (2002), Hutchinson and Richman (2006) and Curry (1987). Each major publication was only possible due to the archaeological work conducted on multiple occasions by East Carolina University and the Office of State Archaeology.

More recent research that has involved the site in some capacity arrived in the form of graduate theses which incorporate the Baum Site as a comparative tool in analyses of "health," biodistance, and mortuary analysis. Of the most recent theses that incorporated data from the Baum Site, a major focus has been placed on biodistance analysis, or an analysis that uses dental measurements to estimate genetic similarities (Killgrove, 2002; Killgrove, 2009, Weidner, 2018; Kakaliouras, 2003; Griffin, 1993). Other investigations have incorporated the Baum Site in reviews of maritime archaeological site loss through coastal erosion (Petrey, 2014) or as a comparative tool in paleopathology and mortuary practices in the coastal region of North Carolina (Souther,

2014; Vasalech, 2011). Other than Speck's consideration of the inhabitants of the Baum Site from the perspective of language and migration, most modern research has effectively implemented a biocultural framework to the findings.

Paleopathology of Precontact North Carolina

The paleopathology of the Baum site has served as both topics of discrete case studies, and sources of comparative data for other geographically similar sites. These analyses have largely been completed in a series of analyses conducted by Dale Hutchinson and Crystal Vasalech (Hutchinson, 2002; Hutchinson, 2006; Vasalech, 2011). In addition to paleopathological reconstructions, human variation has been addressed through an analysis of biodistance.

Employing the non-destructive methods of computerized tomography, Vasalech's (2011) goal was to reconstruct the presence of cribra orbitalia through CT scans, and reinterpret the etiology of the pathological lesions. Although causation is based upon interpretations of diet, health, and environment, the crux of the paper was founded on the accuracy of discovering cribra orbitalia through non-destructive and digital methods. Vasalech discovered that in some cases, splices of the CT scans offered a better understanding of diploic expansion, in place of porosity (Vasalech, 2011).

Hutchinson (1998) evaluated the possibility of treponemal infection at the Baum site by analyzing a series of craniofacial lesions and pathological abnormalities observed in some unassociated postcranial remains. He argued that differential diagnosis supports the interpretation of probable treponemal infection at both the Baum site and at the

Hatteras Island site. In addition to the cavitation of the nasal area on individual “KK” and the raised nodules of the frontal bone, the postcranial remains indicate periostitis on the short bones and otherwise identified on the long bones through significant medullary obliteration of the long bone. In extreme instances of periostitis, destructive lytic reactions are identifiable (Hutchinson, 1998).

Hutchinson revisited treponemal infection in a 2006 publication and focused on patterns of treponemal indicators in human remains both temporally and regionally. The study finds that over the nearly 2,500 individuals sampled from throughout the region, indicators were solely manifested in cranial lesions and that dental lesions could not definitively be tied to treponemal infection. The work concluded that infection followed the trends of population density (Hutchinson, 2006).

Hutchinson’s research on treponemal disease at the Baum site provides support for the notion that treponemal disease existed in the New World, prior to European contact. Three hypotheses offer an explanation of the natural history of treponematosis through the world. The Columbian hypothesis posits that where Christopher Columbus and his crew introduced the disease to Europe, after it was contracted in the New World. The second hypothesis, the pre-Columbian theory, argues that venereal syphilis was already present in Europe, not clinically recognized as such, and introduced to the New World through contact. It is this approach that delineates venereal syphilis from other treponemal diseases (previously and broadly classified as “venereal leprosy”). The Unitarian model is the final hypothesis that envisions treponemal disease evolved independently of one another in different locations around the world. Stemming from

Treponema pallidum, treponemal disease is dynamic and highly evolved to fit the environment in which it is incubated. The primary supporter of this vision pinpoints the affliction yaws as the disease from which all other variations stemmed (Bogdan and Weaver, 1992).

Bogdan and Weaver (1992) argued that the pathological lesions that are reminiscent of treponemal disease that exist in the North Carolina coastal regions were pre-Columbian, considering the dissimilarities of pathological lesions seen between venereal and endemic treponemal disease. Gathering data from Burial 1 at the Baum site, the authors also suggest that a sudden and virulent infection of treponemal disease did not result in sudden or quickly onset deaths. Rather, the remains indicate a chronic treponemal infection, which supports both the Columbian and Unitarian hypotheses (Bogdan & Weaver, 1992).

In addition to discussing the Baum site as a case of possible treponemal disease, Hutchinson (2002) also incorporated the remains from the Baum site in a comprehensive review of settlements in North Carolina. Notable to the proposed direction of research, Hutchinson (2002) incorporated the human skeletal remains from the Baum Site in a comparison of skeletal and dental pathology, and as subject matter in the discussion of mortuary rituals, ossuary burials, and demographic reconstructions. Hutchinson also includes the Baum site in a reconstruction of the North Carolina coastal region. Admixed into the data collected from a series of other Middle and Late Woodland sites, the Baum site serves as a data set for a series of tests that overview the existence of pathological lesions by region, rather than by site. As outlined by Hutchinson (2002), the purpose of

the chapter was to reconstruct the pathological lesions in a manner that encouraged the interpretation of discrepancies in nutrition and “health” of inner and outer coastal populations, when biological sex was also a factor (Hutchinson, 2002). The data are categorized in two different table sets: one that provides the frequency counts of elements that express pathological lesions, and another that expresses the percentages of elements that express pathological lesions. Included in the broad spectrum of pathological offenses that impact the bone and dental arcades include: alveolar infection, premortem tooth loss, alveolar resorption, carious lesions, dental chipping, congenital defects, enamel hypoplasia, porotic hyperostosis, stellate lesions, trauma, tumors, external auditory exostoses, alveolar infection, premortem tooth loss, and nonspecific infection.

Within the paleopathological analysis, Hutchinson (2002) hints at future applications of paleodemographic analysis. Existing estimates at the time of publication were reconstructed through MNI, which assumes the smallest possible estimate of individuals interred, as represented by the maximum number of a specific element. Forethinking, Hutchinson cites the early inklings of possible pair-matching in his text. Mentioned in passing, a “refinement of this symmetry MNI calculation is to employ matching of elements using age, sex, and size in addition to symmetry” (Hutchinson, 2002, pg. 57).

CONCLUSION

This chapter outlined the historic and archaeological background of the North Carolina Algonkian, the European conceptualizations of Algonkian culture, and the discovery and excavation of ossuaries known as the Baum Site. This chapter sets the stage for the type of paleodemographic reconstruction that is at the core of this thesis. Such paleodemographic and bioarchaeological approaches can further exist in reconstructing various dimensions of ancient identity, including the people interred at the Baum site.

CHAPTER THREE: THE HISTORY OF METHOD AND THEORY IN PALEODEMOGRAPHY

Bioarchaeology is innately capable to pursue complex, multifaceted questions involving past configurations of human biology, society, ecology and microevolution that connect to the many contemporary problems and embodied identities that are carried among the living today. Given the importance of demographic variables on modern policy, economy, economic and social structure, the field of paleodemography resonates strongly throughout a range of settings. In archaeology and bioarchaeology, paleodemographic variables help establish a range of fundamental understandings that can be extrapolated to a diversity of questions. These include the development of protocols and methods best suited to consider and address a variety of archaeological and historic questions involving some of the most complex funerary contexts of all: disarticulated secondary burials.

This chapter examines the history of the methods that have been developed to reconstruct the paleodemographic characteristics of archaeological skeletal samples with special emphasis placed on disarticulated individuals and secondary burials. Deeply rooted in paleontological origins, these archaeological methods have addressed the complexities associated with fragmented and commingled remains. In preparation for this discussion, it is important to review the taphonomic mechanisms that translate remains from an immediately deceased body into part of the archaeological context. The final

portion of this chapter addresses the paradigm shift that emerged in the 1980s as a result of a critique that called for the end of paleodemography in bioarchaeological inquiry.

What emerged from this call, however, was a staunch defense and reformation of the knowledge that accompanies its practice along with, a critical and carefully conceived appreciation of the limitations and complexity of paleodemography. Recent advances in paleodemographic inquiry such as the Most Likely Number of Individuals (MLNI) technique, which is explained in a later chapter, are built upon the history of animal population studies, a nihilistic critique of paleodemography, and eventually, techniques that have incorporated the realities of missing data. Finally, the applicability of these recently developed techniques are shown in a series of different research contexts.

BIOARCHAEOLOGY: A BACKGROUND

Bioarchaeology emerged in the 1970s as a synthesis between archaeology and the study of human remains by physical anthropologists. Bioarchaeological investigation formally emerged in the literature in 1977, when Jane Buikstra made the case for the range of information that could be documented though an interdisciplinary approach to the human remains at the lower Illinois River Valley (Buikstra, 1977). The overarching framework employed in bioarchaeology manifested in the indisputable and interwoven connection between biology and culture.

Culture manifests extraordinary diversity through space and time. Even more, it changes, evolves, and transforms in response from any number of contributing factors,

such as ecology and as access to resources based on socioeconomic status (Goodman, 2013). Social contexts can be delineated in their most basic sense, in the traditional model of vertical and horizontal differentiation. Vertical differentiation can be understood in terms of broad hierarchical variation. Horizontal differentiation focuses on the differentiation of groups within the same social strata, however that may have been constructed (age, gender, socioeconomic specialization). For instance, vertical differentiation may be broadly understood as a class of royals, commoners, and peasants. Horizontal differentiation can break down the commoner group into more specific categories, such as merchant or craftsperson (Parker Pearson, 1999). Regardless of how context is constructed from appropriate evidence, recognition of culture's impact on the body effectively places the individual in the contexts that made the experienced life course possible (Goodman, 2013).

The biocultural approach is espoused by most bioarchaeologists today. This philosophical and conceptual approach attempts to understand entwined relationships, between the living humans and their larger cultural, social, and physical environments. It is in stark contrast to the discipline's past infatuation of human variability and the supposed inherent differences it posed with race. At this juncture, the biocultural approach can contextualize variability and skeletal indicators of "health" in the environments which make those manifestations possible. In this sense, nearly all information gathered from human remains embody a cultural and behavioral meaning (Zuckerman and Armelagos, 2011).

An example of recent developments in bioarchaeology focus on models of life history that have the potential to shed light on the experiences that impact or contribute to the embodied "health" of an individual. Major new developments, such as the Developmental Origins of Health and Disease (DOHaD), focus on the early life experiences of an individual, and the possible negative trade-offs an early reallocation of energy for survival has on morbidity. Contexts of life history models extend on the physical manifestation of biological stress through physiological constraint or adaptive plasticity, and the surrounding culture that has the potential to mitigate or instigate the bodily response to the stress (Temple, 2019).

In many bioarchaeological studies, skeletal indicators of biological stress and are studied in the context of a specific temporal and geographic setting. Compounded on these broader contexts, socioeconomic status, biological sex, and age are often incorporated as variables with known impacts on "health." Therefore, the analyses of virtually any kind of skeletal data involving every imaginable scale, scope, and questions depend on paleodemographic reconstructions as the most critical foundation stone.

PALEODEMOGRAPHY: WHAT IS IT?

Paleodemography can reconstruct the age and sex structures of archaeological populations, along with elements of their mortality and fertility (Meindl and Russell, 1998). The field emerged in the 1960s and 1970s and was characterized of highly optimistic and over-reaching applications of modern demographic methods to ancient

skeletal samples. Then, in the wake of a withering critique by Bouquet-Appel and Masset, the field reoriented itself to embrace analyses of spatial distribution, female fertility, population density, and increasingly sophisticated methods to estimates of age and sex. In an even more integrative fashion, the growth and maturation of paleodemography over the last three decades has demonstrated the capacity to consider rates of population growth and decline, which may include patterns of migration.

Although fertility is not addressed in this research, it is an important facet of paleodemographic inquiry. When contextualized with the surrounding culture and environment, estimates of population size through fertility and mortality, and the stable population theory can result in a suite of interpretations on the relative stability (or lack thereof) of a population. Estimates of fertility, for example, were previously derived from maternal mortality rates and population age structures, which are problematic since this cannot be accurately estimated from a cemetery context. Crude birthrate can be interpreted as a reflection of female or maternal health (Klaus and Tam, 2009). Conversely, fertility can be estimated from the total fertility rate, or TFR. Under a stable population model, TFR represents the average number of live births for women between the early reproductive age and concluding at the end of the reproductive years (Meindl and Russell, 1998; Howell, 1976; Roth, 1972, Harpending, 1997; Keckler, 1997). Although this technique bypasses the population age structure, determining the age cut-off for the TFR is difficult, given the variation of natural fertility from population to population. In addition, this technique does not operate well with stationary (no growth) populations (Meindl and Russell, 1998; Wood, 1990).

More recent paleodemographic inquiries have moved into the realm of conceptualizations of "health," life history, and evolutionary facets of human biodemography. As mirrored by the advancements made by bioarchaeology as a discipline, paleodemography has slowly been reincorporated into the literature in an increasingly metacognizant and theory-rich fashion, rather than simply existing as a middle-range tool by which research goals are met. That is to say that baseline paleodemographic patterns involving age and sex are among the first categories of information that bioarcheologists observe and analyze on both scale of the individual and of the site or even broader scales. In order to perform, paleodemographic reconstructions of representation and identity, such as age and biological sex, are necessary and inform at the broad and individual level. In addition, methods have been developed with a careful eye on rate of error, accuracy, and precision. In this way, paleodemography has transitioned from being a broadly overreaching approach in the 1970s to a valuable and progressive research design in and of itself. As with any good science and paradigm shift, this has not happened without unease, unrest, and conflict (*sensu* Kuhn, 1962).

Paleodemography: A Methodological Background in Animal Population Studies

Paleodemography has deep roots in paleontological and zooarchaeological research. Useful for tracing patterns of migration, predatory activities and environmental stressors, paleozoological inquiries followed a progressive schema that explained the transition from living to deceased and decomposition to preservation. The taphonomic

histories involve five discrete steps, ranging from the living community and the sample assemblage that are recovered archaeologically (Ringrose, 1993).

The taphonomic histories of remains were adapted and synthesized by Klein and Cruz-Uribe in 1984 from the original texts by Clarke and Kietzke (1967) who addressed unintended biases of different burial patterns, deposition, and preservation. Together, Klein and Cruz-Uribe (1984) outlined how a living community transitions through the following phases: the death assemblage, the deposited assemblage, the fossil assemblage, and the sample assemblage. Described briefly within Ringrose's (1993) text, the formation of a death assemblage includes the decomposition process. Not technically within the site yet, bone accumulation and location impact the composition of the deposited assemblage, which begins when bone accumulation and decay cease (Ringrose, 1993). The fossil assemblage is the part of the accumulation that survived until the time of potential recovery, while the sample assemblage is part of the fossil assemblage that is recovered. The key argument Ringrose (1993) makes is that there are overarching processes that the archaeologist has no control over, and thus, can only possess limited pre-excavation knowledge about these processes (Ringrose, 1993).

Similar considerations of applicability are placed in the spotlight by Horton (1984). This work focused on minimum numbers of individual animals and demonstrates the value of taphonomic faunal analysis in interpretations of hunter-gatherer settlements, as well as more permanent sedentary agricultural or urban populations. Specifically, Horton (1984) analyses the number and distribution of animal remains from rock shelters, middens, and caves, providing consideration to the disposal, preservation and possible

archaeological inconsistencies that befall zooarchaeological remains. While not immediately applicable to human paleodemographic contexts outright, the approaches the author espoused are valuable when considering the characteristics of the assemblage and the methods that can be applied. In addition, the correct usage of terminology, notably minimum, actual and original number of individuals makes an impact on how the data are treated and the importance it carries - especially if interpretations of human settlement can be advanced by the overall better expressions created by work with faunal remains (Horton, 1984).

Early developments in human and faunal paleodemography beyond just age and sex estimations involved analyses of the Number of Identified Specimens (NISP), the Minimum Number of Individuals (MNI), the Lincoln Index (LI) or the Peterson Method (with capture-recapture method), the Minimum Number of Elements (MNE), the Minimum Animal Units (MAU), and the Total Minimum Animal Units (Ringrose, 1993; Shotwell, 1955; Grayson, 1984; Klein and Cruz-Uribe, 1984; Fieller and Turner, 1982; Wild and Nichol, 1983; Krantz, 1968; Poplin, 1976; Seber, 1973; Binford, 1978, 1981, 1984; Chase and Hagaman, 1987; Chaplin, 1971; Gilbert et al., 1981). Each quantification method experiences its own set of strengths and weaknesses that interact differently with the highly selective fossil assemblage phase. In addition to having never preserved in an adequate manner for future research, remains may fall by the wayside and never be documented owing to any number of other factors including collection, recovery, and curation practices that may not be the most effective basis to build the sample assemblage. Misidentification or extensive fragmentation may also make an

element unidentifiable. Each layer of lost information introduces a certain level of error and biases. It is precisely these considerations that the author suggests the practitioner recognize prior to use of quantification methods, how the method works, what it can potentially mean and where it lacks (Ringrose, 1993).

Ringrose (1993) also outlines unintended biases, such as those introduced by fragmentation, misidentification of elements, or a failure to recover elements. These factors were expounded on by Willey et. al. (1997) in an analysis of bone mineral density and the survival rates of different skeletal elements from the Crow Creek site, which is a large prehistoric village in South Dakota. The skeletal elements studied were a result of a massacre around 1350 A.D. Factors that are intrinsic and extrinsic to the remains have fundamental implications for calculations that address the minimum number of elements and individuals. Furthermore and from a more interpretive perspective, the loss of elements impacts the interpretation of events that extend both at the level of individual embodiment (i.e., trauma, allostatic load), and the patterns of treatment that may or may not exist in the mortuary context (Willey et al., 1997).

Mortuary contexts can extend from the careful preparation of the body to little or no ritualized treatment of the dead. Evidence of mutilation and mortuary processing are among the array of cultural information that can be gathered from disrupted and commingled human remains. As exemplified in the case of the Crow Creek bone bed, preservation of the remains shows evidence of perimortem dismemberment such as cut marks along the superior portion of the skull, cut marks along the first cervical vertebrae and gnaw marks along the epiphyses of the long bones (Willey et al., 1997). Extrinsic

post-depositional taphonomic factors build upon the mutilation and decomposition processes and can reduce the bone to near nothingness. Given the extent of pre- and post-depositional taphonomic factors at the Crow Creek bone bed, this case study is valuable to demonstrate the strength of element survivorship in relation to bone mineral density (Willey et. al., 1997).

In order to test survivorship in relation to bone mineral density, Willey et al. (1997) found that there was no statistically significant difference between the sexes when adult age is combined as an average covariate. There were statistically significant differences when ages were not averaged. When ages were not averaged, there tended to be better survivorship in young males over young females, and old females over old males (Willey et. al., 1997).

The elements at the Crow Creek bone bed were subdivided into percentages that when totaled, represented the entire element. The purpose of this endeavor was to show which portions of certain elements are most likely to be lost, and therefore, which elements could not be used to estimate the number of individuals represented in the sample. A second comparative examination compared the bone mineral density between elements at the Crow Creek bone bed and a contemporary sample from the University of Tennessee-Knoxville. Two questions of comparability arose: (1) the differences that might occur between two populations of different periods and ancestry; (2)and the differences in bone density as a result of prolonged exposure to the elements and various types of soil and the more recent exposure to maceration for the removal of soft tissues in the more modern sample (Willey et. al., 2017).

Despite these questions regarding the applicability of comparisons, the authors conducted a single photon absorptiometry analysis, and used a plexiglass panel to serve as an unchanging proxy that represented the soft tissue (Willey et al., 2017). The scans produced information regarding bone mineral content (BMC), Bone Width (BW) and Bone Mineral Density (BMD). Four scans were conducted at varying element percentages and in conjunction with length and width measurements (Willey et. al., 2017). In order to maintain the lack of definitive information regarding the sex of the individuals in the archaeological context, the ages of the modern sample were averaged. In the Crow Creek context, the diaphysis was more commonly represented than the metaphysis and epiphysis, with the femur being the most commonly found element. There also seemed to be a predilection for the survival of right-side segments. The results of the scans and measurements indicate that the segments of elements that survive are highly correlated to the bone mineral density values (Willey et. al., 2017). In a more precise fashion, the radius and ulna have slightly lower levels of correlation, possibly due to the lower bone volume.

THE DEATH OF "FIRST WAVE" PALEODEMOGRAPHY AND EMERGENCE OF MODERN PARADIGMS

Although population studies involving estimations of age were in use prior to the 1980s, they tended to focus upon large-scale population estimates, such as those provided by a census, or the continued use of paleozoological contexts. In addition, estimated skeletal age ranges tended to truncate much earlier than actual age at death, as evidenced

by reference samples, due the lack of understanding of the relationship between morphological degeneration and age. In addition, age ranges were so wide given their inherent ranges of error that they were considered both inaccurate and useless - especially dangerous if contextualized medicolegally. Such fundamental issues set the stage for Bocquet-Appel and Masset's (1982) famous critique. Effectively blowing the lid off of what the authors considered a consistently inaccurate field of study, Bocquet-Appel and Masset critiqued the early 1980s state of paleodemographic practice and suggested its utter abandonment. The wave of reactions to this suggestion are reminiscent of the reactions prompted by the later publication of the osteological paradox (Wood et al., 1992).

The catalyst that prompted the paradigm shift emerged from French anthropologists Jean-Pierre Bocquet-Appel and Claude Masset. The questions and conflicts that are mentioned raise consideration for the value of paleodemography considering ranges of error, such as that found in the average estimated ages gathered from reference samples through a phenomenon later termed by Boldsen et al., (2002) as "age mimicry." Age mimicry is a bias introduced when the age distribution of the reference sample, operating as the informed prior, is inadvertently placed on the analyzed individual by the application of scoring techniques that were based on a specific population (Godde and Hens, 2015). An example drawn from Bocquet-Appel and Masset's (1982) text shows that cranial fusion averages at the age of 27 for one population, and 48 in another. To avoid the effect of reference samples as the source of this kind of error, the authors suggested building comparative systems between

populations with similar age class structures and age distributions. With this suggestion, the authors indirectly introduce a second avenue of paleodemographic error - estimation of population structure. In trying to resolve one problem, the authors encountered yet another complex paleodemographic issue that is hidden in the intersectionality of population-wide age reconstruction, without knowing how to discern the structure of either the reference population, or the one being studied. Given the difficulty involved with estimating age from archaeological samples from possibly incomparable reference samples and the even more complex issue of attempting a specific population-based reference, the authors conclude with their "farewell to paleodemography" (Bocquet-Appel and Masset, 1982, pg. 332).

The reasoning for a "farewell" to paleodemography is established within the article, through the presentation of series of seemingly irreparable shortcomings and compounding biases introduced in age estimation from which any kind of paleodemographic reconstruction would be untenable. Classification during periods of growth are relatively short in comparison to the period of degeneration. As such, growth periods can be more easily broken down into segments. Conversely, degenerative stages become ambiguous and result in a vast age range from which the "rate of misclassified skeletons for a given structure is unknown or unknowable" (Boquet-Appel and Masset, 1982, pg. 325). In addition, "age mimicry" projects biases incorporated from the reference sample. The authors also make a point to discuss the wide ranges of degeneration and the amount of variability expressed within. The greater the variability, the authors argue "the lower its anthropological interest" (Bocquet-Appel and Masset,

1982, pg. 324). In addition to the issue of variability, the ranges associated with degenerative processes create a statistical issue that in and of itself represents a great range of imprecise classifications or classification ranges that are so wide that they convey little to no information.

Quite pessimistic in its tone, Bocquet-Appel and Masset attempted to estimate life expectancy at birth and a quotient for infant mortality. The resulting numbers may seem reasonable, but they often do not and cannot represent past archaeological reality. It is the same issue as addressed before – just as the reference sample has been superimposed on cemetery samples in the past, the reference sample continues to be superimposed on ancient populations. Even though the authors are focusing on population structure rather than just age, "we are brought back, as though by a pendulum effect, to historical demography. There is no way out" (Bocuqet-Appel and Masset, 1982, pg. 329).

In concluding the succinct farewell to paleodemography, the authors suggest that estimating age-at-death is still useful to estimate ethnic relationships, but not from a demographic standpoint (Bocquet-Appel and Masset, 1982). From this angle, the authors believe that it is useless to superimpose unrelated historical data on far removed populations, but to let them speak for the immediate vicinity and time period that they represent - giving some level of credibility to differences in representations of sex, funerary ritual, and other forms of context.

On the heels of Bocquet-Appel and Masset's seemingly final stance on paleodemography, Buikstra et al. (1986) offer an analysis of fertility as a method for estimating population structure at the advent of agriculture. Fixed to a geographic and

temporal sample to better see generational changes, the authors begin with reminding the reader that "explaining changes in population structure are of a fundamental importance in the study of the human past and have therefore assumed prominence in archaeological research" (Buikstra et al., 1986, pg. 528).

Of particular anthropological interest, the Neolithic revolution has been historically regarded as the catalyst for unprecedented population growth. Although some critique this general trend, citing the high death statistics that correlate with increased fertility, an analysis of fertility operates as an avenue from which a comparison of demographic patterns and agriculture can occur (Acsádi and Nemeskéri, 1970; Bocquet, 1979, Bocquet-Appel and Masset, 1982). Agriculture, in this sense, include variables of diet change and sedentism.

From archaeological analysis, the authors discovered that group mobility and access to meat resources could both be considered constants. There was no evidence for increased adult mortality. Trends in increased fertility are not associated or balanced by a calibrated increase of infant mortality, as evidenced by habitation and mortuary size and density, although the authors do acknowledge the biasing effect of taphonomy on subadult remains (Buikstra, 1986; Asch et al., 1979; DeRousseau, 1973; Styles, 1981). The variable with the most influence, therefore, shifted to the availability and processing of high-carbohydrate food for not only the mother, but the weaning child. The processing of food into a soft and more easily digestible form shortened the weaning interval, thus shortening the interval between the birth of children. Evidence for the use of a soft

weaning diet are seen in the early appearance of dental caries in subadults (Buikstra et al., 1986; Cook and Buikstra, 1979).

Although Buikstra et al. (1986) established an example of paleodemographic analysis outside of historic or ethnic context, Bocquet-Appel and Masset (1996) revisited the contentious topic of paleodemography and yet again questioned the promise of results. Specifically, the authors readdressed the errors in paleodemographic age distributions, offered a revised conceptual framework and method in response to the reactions that emerged from the original publication, and spoke to what they perceived as a dearth of applicable consideration that mirroring age distribution received.

To offer suggestions that mitigated the subjectivity and errors inherent to paleodemography, including estimations of the number represented in the archaeological context, the authors focused initially on the theoretical and conceptual problem of mirroring. That is, the authors realize that the calculated age distributions from archaeological contexts mirror the age distributions of the reference sample. Because this is an issue that has foundations in both method and conceptual frameworks, suggestions that address both require individual consideration. Conceptually, estimated age distributions should be optimized against references that are "estimated globally, via a probabilistic approach, and not as a simple sum of the individually estimated age, as is usually done by the traditional method based on forensic medicine" (Bocquet-Appel and Masset, 1996, pg. 571). In practice, this is a much more complex feat. On a theoretically cooperative note, suggestions include an approach that focuses on a historically unbiased estimate of adult skeletons and yet another that aims to outline the demographic ranges of

a population, without a reliable method for age estimation (Bocquet-Appel and Masset, 1996). Even 15 years later, the authors still wrestle with the difficulties proposed in the original article.

In order to avoid age distributions from an archaeological sample mirroring those created from a reference sample, Bocquet-Appel and Masset (1996) suggest the use of global and uniform age distributions. Age distributions gathered from such global contexts would manifest from estimated age classes that are composed "by the information quantity on the age carried globally by the biological indicator(s) and summarized by the correlation coefficient between those age indicator(s) and the age at death" (Bocquet-Appel and Masset, 1996, pg. 571). In order to create the uniform age distributions, the authors suggest the use of 40 mortality reference tables that were gathered from throughout the world. Comprehensive in theory, the authors failed to indicate the process of gathering mortality references. It is unclear whether the mortality references would be gathered at random or based upon a population density threshold.

Comprehensive and impressive in theory, but wildly ambitious, the creation of mortality reference tables from data gathered worldwide would result in vast margins of representation due to global variability. In this regard, Bocquet-Appel and Masset (1996) evaluated an approach suggested by Konigsberg and Frankenberg (1992) using an Iterative Bayesian procedure, "iterated age length key" or IALK, (initially published by Kimura and Chikuni [in 1987]) and the iterative proportional fitting procedure (IPFP) developed by Deming and Stephen (1940) in a procedure for a modern population census. The IPFP "fits" incomplete data, such as that derived from the sample to fit a contingency

table of expected data gathered from other populations. Accompanied by the IPFP analysis, Bocquet-Appel and Masset (1996) claimed to have “historical priority” to the IPFP technique, although the idea was conceived much earlier by Deming and Stephen (1940).

Bocquet-Appel and Masset (1996) intended to address the range of error in adult age distributions - an effort that emerged in conjunction with Konigsberg and Frankenberg (2002), and earlier by Kimura and Chikuni’s (1987) efforts in the application of a technique termed the age-length key, which has a history of estimating the age of fish based on body length. In different instances, both sets of authors that developed the technique initially celebrated the protocol but subsequently questioned its usefulness after a series of negative reviews that brought attention to instances of gross misuse and miscalculation (Kimura and Chikuni, 1987; Kimura, 1977, Konigsberg and Frankenberg, 2002), citing specifically that the age-length key produced biases. These biases, discovered independently by unpublished papers by Fukuda and Shiro Chikuni, exist when age-length keys are created from a sample different from that which informed the length data (Kimura and Chikuni, 1987). Despite the chronological proximity of the age-length key protocols, the goal of Bocquet-Appel and Masset’s review is not to investigate the graphed shape of the distribution or evaluate the validity of the age-length key technique. Instead, they aimed to evaluate the possibility of estimating an average from a sample of a stationary populations through iterative Bayesian procedures, or iterative proportional fitting procedures.

Although Boquet-Appel and Masset (1982) focused heavily on estimates of age and its use in mortality models, representation in the reference sample with an unknown population structure provided cause for a subsequent critique. The development of age of models is prone to the recognized caveat that population structures, that which informs the distribution of age at death through the enumeration of deceased, is unknowable in scope. The incomplete nature of the population structure data is compounded upon the error prone nature of age estimations as, reflected from the populations that serve as known priors to populations being studied. The example given within the work consider the lack of representation of children in the data for reasons that are unknown. Reasons for missed representation include the loss of elements through taphonomic damage, the unknown existence and location of separated burials (Robb, 2013) the low number of deaths at an early age, and sampling bias, among many other reasons (Bocquet-Appel and Masset, 1996). The reasoning behind the critique, therefore, has two implications: 1) the total number of individuals can never be known, for reasons that are unknown, and 2) the mortality models of age are therefore skewed towards those that are represented.

Paleodemographic Origins: Sample Size Estimation

Despite the critique that called for the discontinued use of paleodemography at the broad scale, techniques with advanced application possibilities began to emerge. As extending from a long history of population studies that focus on animal assemblages and the deep-rooted relationship to human paleodemography, Le Cren (1965) noted that the

Petersen Method (called the Lincoln Index by ornithologists and mammologists) was independently developed by Dahl (1917) and not Petersen in the late 19th century. Still, Petersen is credited with being the analysis of the mortality rate of a stable fish population while working at a fishery. Although recognizing that statistical re-configurations of the capture-recapture method (encompassing both the Peterson Method and the Lincoln Index), Le Cren's work was important to demonstrate the integrative and interdisciplinary history of paleodemography, and how it has been improved upon by these multiple approaches and perspectives (Le Cren, 1965).

Drawing upon the Petersen Method, Wolter's (1990) publication revisits the capture-recapture estimates in modern population census studies, and factors such as known sex ratios and an independence clause. Initially proposed to estimate the population size of France, capture-recapture estimates can be broadly understood as a tool to estimate total population size from an observation and probability that individuals in the initial capture stage would also appear in the secondary recapture stage (George and Robert, 1992; Laplace, 1786; Seber, 1982; Otis et al., 1978; Pollock, 1991). Behavioral independence is an agent in living and dynamic populations, as seen in the results from the application of the Petersen method on the U.S. population. For instance, the Census Bureau identified the sociological and economic causes of downward biasing of males in the population. Because of the implications of decisions that are based upon the census data, a technique of circumventing behavioral impacts may include the treatment of the two biological sex independently of one another (Wolter, 1990).

Implications of behavioral independence are necessary and provide important information regarding estimates of demographic structures in dynamic living populations. For instance, Wolter's (1990) consideration of sex does support the idea that specific sociological and economic factors, such as having no fixed address or fear of losing welfare payments, may influence capture-recapture estimates in census related capture-recapture exercises. Given the static nature of archaeological assemblages, capture-recapture trends of sex are limited to estimates on a series of skeletal indicators. In light of this understanding, commingled elements and the capture-recapture protocols are dictated by side, skeletal element robusticity, density, size, and possible bilateral lesions. Such factors are reminiscent of the methods employed by the Lincoln Index, the Petersen Method, and most recent methods for MLNI.

The Lincoln Index is possibly the most important estimation tool that was used in the creation of the specialized technique, Most Likely Number of Individuals (MLNI). As outlined in Adams and Konigsberg (2004), the Lincoln Index (LI) is a variation of MNI that estimates the original number of the population that is, at the least, partially represented in the assemblage. Minimum Number of Individuals (MNI) is a much more restricted technique, that estimates the minimum number of individuals from the maximum number of distinct elements (Adams and Konigsberg, 2004; Adams and Konigsberg, 2008; Ubelaker, 2002; Orchard 2005; White, 1953; Backo, 2016). It is also significantly impacted level of element fragmentation (Backo, 2016; Mundorff et al., 2008; Ubelaker, 1974).

Although almost exclusively applied to living animal populations, the Lincoln Index and Chapman Estimator is useful for bioarchaeological and population studies. They can test census accuracy and are flexible enough for use in research that can never guarantee an accurate observation of total number - such as archaeological collections that have been impacted by taphonomic forces. The taphonomic bias incorporates the known phenomenon of random data loss. Because the equation considers and accounts for taphonomic or recovery related data loss, it is more effective when applied to larger skeletal samples (Adams and Konigsberg, 2004). In addition, the data loss must be randomly distributed for the equation to account for data loss (Backo, 2016).

In order to capitalize on the strengths of all estimators, Backo (2016) developed an estimator that averaged the estimated number of represented individuals from the Lincoln Index, MNI and MLNI. This is known as the derived number of individuals, or the DNI. Likened to the Grand Minimum Total (GMT), the calculation adds the number of successful pair matches to the number of individual elements that were not successfully pair matched (Backo, 2016; Adams and Konigsberg, 2008). Each successful pair match represents an individual (as seen in MLNI) and the single, independent elements that did not have a pair are assumed to be from independent individuals (as seen in MNI). Testing of the DNI suggested that the element with the most accurate estimating power was the element that most closely reflected the MNI estimates (Backo, 2016).

APPLICABILITY OF ESTIMATING HOW MANY FROM COMMINGLED REMAINS

Although the mechanics by which Most Likely Number of Individuals (MLNI) will be addressed is presented in a later chapter, the development and successful application of a technique to remains from a commingled context is warranted. Two such case studies exhibit the utility of the technique.

The Larson Village site in Illinois serves as a test of applicability of MLNI. It was excavated in 1963 and 1964 as a salvage project under the Smithsonian Institution River Basin Survey. In total, there were 29 circular depressions, which were later determined to be the remnants of lodges. Of the scatter of depressions, only three were excavated (Adams and Konigsberg, 2004).

Initial interpretations of the site indicated that the lodges might have been used as the final resting place for individuals who died of an epidemic such as smallpox. Analysis of the remains indicated a much more violent death. Extensive perimortem trauma suggested that the individuals were killed in battle and were subsequently subjected to mutilation by the offending force. Mutilations included scalping and the removal of limbs or other portions of the body for trophy keeping purposes. In addition to the traumatic injuries and mutilation, there is evidence for significant scavenging damage to the bones by carnivorous animals (Adams and Konigsberg, 2004; Bass and Rucker, 1976; Owsley et al., 1977).

Although the remains had not been bundled and placed in a secondary location, there was significant physical overlap between the skeletal remains. It is likely that the

individuals either fell where they died, or the deceased were placed in quarters together once the fighting concluded. Scavenging further commingled the remains. Given the amount of overlap, four elements were chosen for pair matching. This included the humeri, *os coxae*, the femur bone and the tibiae (Adams and Konigsberg, 2004).

Results of MLNI analysis resulted in a higher estimate than what was produced from the much simpler MNI. When point estimates were combined, it was estimated that the three lodges hosted 50 individuals. MNI estimates calculated only 44 individuals. The higher estimate provides evidence for the high recovery rate of elements and expresses the typical underestimation of individuals by MNI (Adams and Konigsberg, 2004). The MLNI estimate is meaningful, considering the context in which the skeletal remains were discovered. Although not intended to mimic an ossuary, the level of disorganization made the Larson Village Lodge 21 site suitable for techniques that would be best suited for the level of commingling often reserved for secondary burials. It is unclear whether the individuals died within the lodges or were placed there once the conflict concluded. In either instance, the remains were left exposed for some time, as evidenced by the damage from carnivorous animals. The remains were sealed once the lodges collapsed (Adams and Konigsberg, 2004).

MLNI has also proven effective in large scale secondary burials in the Southern Levant. Sheridan's (2016) bioarchaeological analysis of various sites in the Levant evaluates the interplay between archaeology and anthropology in a region that has a deep history of human migration, settlement and the practice of "'Big God' religions" (Sheridan, 2016; Osman, 2013; Segev, 2000). Given the political and social realities that

dictate archaeological inquiry, and especially interaction with human remains, the author highlights progress in some of the largest archaeological centers of the Near East region – despite the persistence of archaeology operating as a standalone discipline that only tacitly, if at all, mentions human remains (Sheridan, 2016; Johnson, 2010; Knüsel, 2010; Perry, 2007).

The Most Likely Number of Individuals technique (MLNI) has been successfully applied to the A22 charnel house, which at one time stood in Bab adh-Dhra just off the southern portion of the Dead Sea. In the case of Bab adh-Dhra's A22 site, the estimated number of individuals better matched the archaeological contexts of the large building in which the remains were discovered. The charnel houses were a visible part of the town's landscape and recreating the number within have been analyzed in conjunction with age, sex, indicators of violence, and MSM indicators of activity to "detail changes in Early Bronze Age social dynamics" (Sheridan, 2016, pg. 129).

In addition, MLNI estimates from a tomb at Byzantine St. Stephen's monastery, the largest church in the Byzantine Jerusalem for almost a century, better aligned with written documents that provided evidence for community size than the MNI estimates. Specifically, MLNI doubled the number of MNI estimated individuals housed within the tomb (Sheridan, 2016; Sheridan and Gregoricka, 2015; Binns, 1994; Chitty; 1995).

Comparative to the successes of MLNI, MNI has been reassessed to show the differences in number of estimated individuals by shifting focus to different calculation techniques. In the realm of MNI usage, the traditional method has resulted in two

additional techniques – both of which are variations of the traditional method (Lambacher et al., 2016).

The proposed techniques include the traditional form of calculating MNI, which is to discern the greatest number of distinct elements from an assemblage, the zonation method, and the landmark method. The zonation method narrows the focus from the element as a unit, to an element that can be categorized as a zone. The zones are areas of the bone that are not easily broken, are present in fused and unfused elements, are free of age bias, and are species specific in appearance and morphology. The premise of the zonation method is based on the identification of elements, even if fragmented, to discern the number of individuals in the assemblage. If two fragments can conclusively be matched, the elements will count as a single individual. MNI is derived from the most populous element (MNE) of a certain side, which is then separated by age element (Lambacher et al., 2015; Knüsel and Outram, 2004; Dobney and Rielly, 1988; Watson, 1979).

The landmark system relies on representation of particular landmarks in an element, rather than the element itself, for calculation of MNI. Such landmarks include articular surfaces, bony processes, nutrient foramina, and the diaphysis of long bones that are easily recognizable. If an element fragment is discovered, any observed landmark on the fragment must be over 50% observable for the fragment to represent an individual, taking into consideration the bilaterality of the element. For human adults, there are 67 landmarks on the cranium and mandible. Other post-cranial elements range in anywhere from two to 18 landmarks. MNI is calculated by identifying the largest number of

landmarks, from the MNE, from a single side and separated by age and sex (Lambacher et al., 2015; Mack et al., 2015). An even newer approach employs an editable database that standardizes notes of bone loss, fragmentation, paleopathological modifications, trauma, among other categories, by element specific zones. As a comprehensive database that has been tested on two large field schools, landmarks (which are mirrored on bilateral elements) are identified for the cranium, the *os coxae*, the femur bone, the fibula, the tibia, the patellae, and the vertebral column. An additional database form is provided for the dentition (Osterholtz, 2019).

When applied to an archaeological context of commingled and fragmented remains at the cemetery of Santa María de Zamartze, the authors (Lambacher et al., 2016) note the disconnect between the traditional MNI estimation, estimating 84 individuals, the zonation MNI at 68 individuals, and finally, the landmark method at 61 individuals. Because the techniques depend heavily on identifying portions of elements, whether it is identified as a zone or a landmark, there is a chance that fragmented elements may count twice towards a single individual. It is from this possible bias that the landmark rule of 50% is advisable (Lambacher et al., 2016).

Aspects of these altered and elaborated MNI techniques are reminiscent of MLNI estimates. Instead of discerning 50% of landmark centers or zones of elements, MLNI focuses on more robust elements that, with prior study, tend to survive in the archaeological context. Because the larger elements tend to survive in greater portions, this can be viewed as a correlate to the better preservation of elemental zones. In addition, the pair-matching that occurs can be derived from the similarities of element

landmarks. By this rationale of tangential similarities, MLNI still tends to provide better estimates when compared to the traditional MNI – it also does so without the complexities of cranial fragments, and small, commonly lost elements. Furthermore, MLNI depends on the controlled use of robust elements for pair matching. Because of the necessity for complete or nearly complete elements, double counting a single element is not as problematic (Adams and Konigsberg, 2004).

CONCLUSION

This chapter provided an overview of the history of paleodemography and the paradigm shift that kickstarted its regrowth in the discipline after suggestion for its abandonment emerged in bioarchaeological literature nearly 40 years ago. In lieu of the data considered in later chapters, discussion of the paleontological research that served as the catalyst for methods that could contribute to commingled and fragmentary burials was needed. In addition, the development of sample composition estimators has set the stage for the advancement of theory that may be applied in many, but not all, bioarchaeological contexts. Finally, the successful application of the Most Likely Number of Individuals technique has provided evidence for the utility of methods that are built to deal with complex burials, such as transition analysis addressed in the previous chapter. As such, estimating the number of represented individuals within a sample is the foundation for any attempt to more holistically interpret data sets that have traditionally been ignored.

CHAPTER FOUR: METHODS AND CHALLENGES OF SKELETAL AGE-AT-DEATH ESTIMATIONS

Age-at-death estimations are among the most important forms of information in any bioarchaeological investigation. In many scenarios, age-at-death estimations are the single most fundamental baseline variable upon which the study of virtually everything else is predicated, from estimations of disease prevalence to population histories. In this way, age-at-death also speaks to the effects of the lived environment – both at the time of death, and the factors that contribute over time to an individual's morbidity across the lifespan. Age-at-death estimations, beyond utility within paleodemographic reconstructions, continue to operate as a foundation to relatively new approaches, including survivorship, life history models, and the paths of morbidity, mortality, and phenotypic plasticity related to the Developmental Origins of Health and Disease (DOHaD) hypothesis (Barker, et al., 1986; Barker et al., 1989; Barker et al., 1993; Temple, 2019).

Yet, age-at-death estimations are far from perfect. The topic is entwined in a long history of methodological critiques that draw attention to the limits of knowable biological information drawn from the deceased. Estimations of age are indeed estimates, and as statistical accuracy increases, precision decreases and age estimation intervals become sometimes impractically wide. Despite such uncertainty, recent developments

have permitted for age estimations from even the most fragmented of remains. In an era where modern anthropology has not been able to extend the same amount or scope of theoretical frameworks to fragmentary and commingled burials, the recent ability to apply some degree of age-at-death estimation lays the groundwork for advancements in method and theory.

This chapter focuses on the history of age-at-death estimation and the persistent challenges that have plagued quantification of age from skeletal remains – regardless of the level of skeletal completeness. It also provides an overview of the development of osteological age-at-death estimation, which include a series of technical successes and failings along with a consideration of deep-rooted theoretical constraints in paleodemography. The chapter eventually focuses on each technique that has established the foundation upon which transition analysis was developed and employed. Drawing on these steppingstones, there exists an indisputable tension between accuracy and precision. Despite these constraints, the use of combined diversification of scoring indicators has resulted in significant developments for identification of the outermost limits of age estimation. In addition, transition analysis is applicable to fragmentary or otherwise incomplete datasets, which makes it extremely valuable in a diversity of archaeological contexts.

PALEODEMOGRAPHIC ORIGINS: AGE-AT-DEATH ESTIMATION, EVOLUTION OF TECHNIQUES, AND PERSISTENT CHALLENGES

In light of the debate surrounding the validity, accuracy, and continued use of paleodemographic applications and approaches, it is important to understand the history and functionality of today's most common methods of age-at-death estimation. This history can be best understood in two phases – the formative research that established the groundwork of age-at-death estimations, and the emergence of methods that employed multi-element analysis.

Formative Research

One of the earliest attempts to accurately estimate age from skeletal remains was published by T. Wingate Todd in 1920, with criteria by which the male pubic symphysis could be scored. Todd's intentions were to also develop scoring methods for "female, negro-hybrid, and Primate pelves generally" (Todd, 1920, pg. 326). He studied the various indicators thought to reflect chronological age, such as endocranial and ectocranial suture closure, occurrence of lipping on the margins of bones, ossification of cartilage and overall texture of the bones. Todd noted that some joint surfaces show sequences of modification associated with age more so than others. In addition, Todd briefly considered the development of age estimates from epiphyseal fusion of the sterno-clavicular area, the manubrio-gladiolar articulation, and the eventual fusion of the vertebral end plates. Of the litany of elements that were considered, Todd stated that

“when the second of these also at last, in the early thirties, fails to register the individual’s age, the symphysis pubis still retains its role of time marker” (Todd, 1920, pg. 288). This observation still rings true today. The pubic symphysis marks various stages of development and tends to descend into un-patterned degenerative entropy at around the age of 40-45. Although it descends into biological disorganization, there are measurable morphological changes that correspond with advanced age. As such, age-related information is not truncated so easily with the pubic symphysis relative to the other elements Todd considered.

Noting the difficulties in assigning stages to adult age, Todd acknowledged that there are certain phases of morphological change that tend to occur with regularity. Alterations to the expected progression of morphological change “may be accelerated, retarded or possibly even inhibited at any stage” (Todd, 1920, pg. 291) meditated by infection or nutritional deprivation. Despite these possible interruptions, Todd concluded that the evidence for age related morphological changes was still strong enough to serve as the impetus for further investigation.

Todd dedicated a major portion of the publication to painstakingly describing technical methods of scoring, morphological change of the pubic symphysis over time, and the respective age ranges associated with the appearance, disappearance, or alteration of characteristics. The study resulted in the definition of ten morphological phases associated with specific age ranges that spanned anywhere from 1 to 5 years, and that began at age 18. Eighteen was chosen as the earliest definable age range due to previous investigations that suggested that the effects of growth and development on morphology

was negligible after the 18th year. At this age, morphological changes of the pubic symphysis can be understood as a "metamorphosis" (Todd, 1920; Cleland, 1889). Hesitant to assign an age to the conclusion of developmental momentum, Todd (1920) suggested a flexible parameter that corresponded with the earliest signs of degeneration. On the same grounds of flexibility, Todd's tenth and final phase truncated at age 50 based on the level of erosion of the symphyseal surface, the loss of the ventral border, erratic ossification, and general disfigurement.

Todd's Ten Phases were the standard in adult skeletal age estimation for nearly 40 years until Thomas McKern and T.D. Stewart noted a series of incongruities in age-at-death estimations when attempting to identify American war dead. Using the methods outlined by Todd in 1920, McKern and Stewart (1957) discovered a tendency to overestimate the age of individuals when they were compared to the records kept on the fallen soldiers. Their report, therefore, was written with two goals in mind: to establish a more comprehensive understanding of age-related variation for the American population, and to establish a better age-at-death estimation technique that would provide more uniform and accurate results. In doing so, the authors acknowledged some of the limitations that the study faced, such as the known range of ages associated with military service and instances of commingling and taphonomic damage. Considering the nonrandom sampling present inside a wartime death assemblage, the study is arguably the most representative of the male, American population within a narrow age range (McKern and Stewart, 1957).

McKern and Stewart (1957) therefore focused to produce a comprehensive study of age-related changes discernible from a series of markers including cranial sutures, the eruption of the third molars, the epiphyseal fusion of the extremities, the morphology of the *os coxae*, the clavicle, the vertebral column, the scapula, the sternum, the bony sacrum, and the ribs. Working from the literature published by Todd in 1920, the authors offered their own alterations to the early method.

McKern and Stewart (1957) suggested that Todd's 10 phases were not dynamic enough to encompass the reality and complexity of actual human variability, despite the abundance of scorable features the phases encompass. Their critique acknowledged the validity of using the pubic symphysis but sought to modify approach for greater accuracy. As a result, McKern and Stewart reduced the number of diagnostic pubic symphyseal features used to estimate age from nine to three, with five morphological grades within each feature. The three features that were chosen included the dorsal plateau, the ventral rampart, and the symphyseal rim (McKern and Stewart, 1957). The five grades measured the progressive alterations and degeneration of the symphyseal characteristics.

Origins and Development of Contemporary Multi-Method Techniques

As addressed above, previous age-at-death estimation work employed a single skeletal indicator. Only three years after McKern and Stewart's (1957) technique development using the pubic symphysis, techniques that began to incorporate ages from multiple indicators began to emerge. Developed in 1960, the Acsádi-Nemeskéri method

was created using a reference sample of 105 individuals ranging in age from 23 to 90. Of the 105 individuals, 61 were males and 44 were females. Of these, only 13 females were between 23 and 40 and only 27 males were between the same age range. Producing even more constraint on the analysis of early degenerative morphological change, there was only one female who represented the ages between 23 and 30. Despite the dearth of evidence corresponding to young females, the classifications offered by the authors seem to be heavily focused on identifying general markers for the very young and the very old based on the pubic symphysis. The intermediate phase, largely characterized by the creation and emergence of a ventral rampart, is not mentioned at all. Rather, what became known as the "complex method" focused on the rate of cranial suture closure, the proximal humerus, the femoral spongiosa. "Complex" emerged as a descriptor of the method because of the early attempt to employ multiple indicators as a form of age-estimation through an averaging function (Acsádi-Nemeskéri,1970; Brooks and Suchey, 1990; Kemkes-Grottenthaler, 2002).

Tests of this method revealed the problems that stemmed from morphological ambiguities when females were overwhelmingly represented between Phases 3 and 4 at 47% and 48%, respectively. Given the confusing and ambiguous nature of attempting to score the pubic symphysis between Phase 3 and Phase 4, the Acsádi-Nemeskéri technique failed to perform beyond classifying an individual as younger than 50, around 50, and older than 50 (Brooks and Suchey, 1990). Still, this method is recognized for its historical significance in that it was the first to develop a true multi-marker age

estimation system based on independent yet complementary age-related changes in the skeleton.

Given these problems and uncertainties with Todd's Ten Phases, McKern and Stewart's work, and the Complex Method, a team led by Owen Lovejoy began work to improve skeletal age estimation which led to a multi-article special issue of the *American Journal of Physical Anthropology* in 1985. They developed and published a new method of estimating age-at-death through scoring of the auricular surface of the *os coxae*, scoring techniques of the cranial sutures, sterno-clavicular fusion, and cortical bone dynamics associated with age (Mensforth and Lovejoy, 1985). Although admittedly more difficult to score than the pubic symphysis, the auricular surface of the *os coxae* is regarded as being more readily usable due to better preservation of the more robust peri-auricular region. Drawing upon years of research that focused on the limited mobility of the joint, the composition of the cartilage, and the flexibility of the cartilage that permitted mobility during childbirth, the scoring techniques developed here echo Todd's ten-phase system (Schunke, 1938; Sashin, 1930; Brooke, 1924; Prentiss, 1917; Weisl, 1955; Frigerio et al., 1974; Cohen et al., 1967; Soholt, 1951; Solonen, 1957; Colachis et al., 1963; Bickel and Romness, 1957; Newton, 1957; Todd, 1920). In addition, the results of estimated age-at-death extended the age categories beyond the previous maximum of 50, truncating with a general category of 60 and above (Lovejoy et al., 1985).

Highly descriptive in their terminological characterization of features of the auricular surface, Lovejoy et al. (1985) also describes in detail the series of

morphological changes that begin in the young adult phase and persist in the mid-adult and early senescent phases. Beginning with the earliest presentation of morphological change, age ranges are roughly four years in length until age 50. This approach was admittedly better, but still not immune to the problems that plagued early developments of age-at-death estimation, entropy in the auricular surface prompted the second to final stage to extend for ten years, with an open-ended age greater than the age of 60 (Lovejoy et al., 1985).

As demonstrated by the open-endedness of the final stage and the ambiguities that arise with greater entropy, Lovejoy et al. (1985) suggested that features of the auricular surface may fall into multiple age ranges. Given the ambiguous nature of estimated age-at-death, the authors suggested that each practitioner discern which feature of the auricular surface best represented the biological aging process. Determination of the most representative feature would allow the practitioner to determine which phase it corresponded to. Because the features of the auricular surface may provide varying age estimations, Lovejoy et al. (1985) indicate that the apex and retroauricular surface, otherwise known as “auxiliary indicators,” could also be consulted to provide further evidence for a certain age range.

The authors suggest that estimating age within a range of 2 or 3 years would require practice but could be performed by determining the texture of the surface, which is paramount, and the topography of the surface. This practice would consider the degree of granularity of the surface, followed by a consideration of the surface topography. In each scenario, Lovejoy et al. (1985) suggested that age-estimations based upon sex

impacted characteristics should be avoided. For instance, the apex is particularly vulnerable to morphological change based on proximity to the preauricular sulcus, which tends to be more defined on females.

The next major step in the saga of osteological age estimation took the form of the Suchey-Brooks method, developed by Judy M. Suchey and Sheilagh T. Brooks. Their method has been applied in most osteological studies since the 1990s across a diversity of cultural contests, locations, and timeframes. Originating from a large and diverse modern death sample made available by the Los Angeles County Medical Examiner's office, the development and publication of this technique in 1990 incorporated a larger sample of ages and ethnicities (e.g., biogeographic human variation) than had ever been represented before (Brooks and Suchey, 1990). Sex-based variation was also finally considered and was a key element of the Suchey-Brooks method, with separate standards developed for males and females. In addition, it broadened the existing age ranges established by the Acsádi-Nemeskéri method.

Despite the focus on a single element, the technique's accuracy has been evaluated using collections with known age-at-death data. In work that involved individuals from modern contexts in the Balkans region, Djurić et al. (2007) found that Suchey-Brooks-derived age range estimations were 89.74% accurate in males, 72% accurate in females, and interobserver agreement at just over 70%. The most used (and useful) diagnostic indicators of biological sex included the relief of the symphyseal surface, lipping, the stage of the symphyseal rim, and the dorsal margin (Buikstra and Ubelaker, 1994). Of these features, characteristics of Stage 2 and 3 were the most

ambiguous and difficult to differentiate. In addition, there were inconsistencies with characteristics between the model's proposed Stage 6 and the physical characteristics expressed in the individuals. This disconnect effectively broadened the age range of Stage 6 to an open-ended status (due to disorganization) and became counterintuitive to the efforts that the Suchey-Brooks method hoped to address (Djurić, 2007).

These findings and other studies like it brought about the realization that population-specific scoring methods might be necessary to develop, each tailored to the features that were most easily scored and most highly correlated to a certain age range in a particular ecogeographic population – and then only applied to that ecogeographic population. Specific to the example drawn from the Balkans, complications emerge regarding the use of an informed prior developed in the United States and applied to Eastern European populations (Djurić, 2007)

The use of informed priors, which provide probability information regarding the parameters of that being analyzed, has contributed to the development of various age-at-death estimation techniques and continued to impose complications of mimicry. In the case of age-at-death estimations, informed priors are the range of probabilities that inform the appearance of certain characteristics given a certain age (Boldsen et al., 2002). In other words, they are a "model." Prompted by a legal case where a lawyer questioned the possibility of overestimation of age in East European countries, Kimmerle et al. (2008) posited that biological variability between male and female skeletal morphology, coupled with developmental trajectories that are impacted by population-level variation, can be deeply influenced by the environment. In this sense, the environment might

include restrictions to food resources, restrictions to healthcare and any other number of biocultural intersections that might impact developmental trajectories (Kimmerle, 2008).

Differences among females might also offer valuable life history interpretations relating specifically to context, especially in modern settings. The case presented by Kimmerle et al. (2008) suggest that restrictions to nutritional resources or health care based on biological sex, culturally constructed gender, or a confluence of both might result in curtailed development or otherwise heightened degenerative markers. Whichever context the females experience, the differences in the appearance of skeletal remains in females will result in older age estimation, whether it is caused by population variability, environment or the intersection of both (Kimmerle, 2008; Kemkes-Grottenhaler, 2002).

Building upon the techniques offered by Lovejoy et al. (1985), Buckberry and Chaimberlain (2002) published a technique that argued it was easier to apply and result in reduced intra and inter-observer error. This method, which generates a composite value likened to the multi-element summary age statistic, was gathered from various features of the auricular surface (Buckberry and Chaimberlain, 2002; Lovejoy et al., 1985). The creation of the composite scores from independent markers arguably established the most reasonable estimated age with little risk of sex-based differences. The use of a composite age also theoretically narrowed the age range into which an individual may fall (Buckberry et al., 2002).

In addition to developing a composite age, Buckberry and Chaimberlain (2002) developed a method that attempted to address the expansive age ranges that permitted the consistent underestimation of older individuals, and the overestimation of age in young

individuals. The underestimation of age of older individuals, controlling for bias based on ecogeographic population or sex, was attributed to age mimicry from reference samples. Age mimicry is an unintended bias introduced by the reference sample from which the osteological age estimators are derived. It emerges through a discrepancy of the age-at-death distribution between the reference sample and the sample being analyzed (Godde, 2015). If the population distributions do not resemble one another, as they typically do not, the target sample will begin to mimic the ages accounted for in the scoring procedure. The issue of age mimicry would also be revisited by Boldsen (2002) in the publication that introduced the use of transition analysis.

Noting the considerable attention pubic symphyseal age ranges received, Buckberry and Chamberlain (2002) focused on auricular surface scoring terminology (the same offered by Lovejoy et al., 1985) including: transverse organization, surface texture, microporosities, and changes in morphology of the apex and retroauricular area. During development, the authors determined that scoring the retroauricular area was a poor estimate of age, which therefore warranted its removal from their developed scoring system (Buckberry and Chaimberlain, 2002).

Much as with earlier iterations of scoring techniques, the composite score was determined by averaging previously independent scores. Acknowledging that the score may land in a range that spans two age categories, a standardization of the score allowed it to be compared far more objectively (Buckberry and Chaimberlain, 2002). In addition, the results gathered from preliminary testing indicate that although the composite score was used to contribute to age estimation, certain features are better independent

indicators of age than others. For example, the pubic symphysis is a better estimator of age than the cranial sutures. While the use of single features is no longer used to provide an indisputable age estimation, they still help confirm the value of multi-variable techniques given the ambiguities caused by degeneration (Buckberry and Chaimberlain, 2002).

Four years after its publication, Falys et al. (2006) applied the methods provided by Buckberry and Chaimberlain (2002) and delivered a series of critiques that question the validity of the technique. The conclusions arrived at by Falys et al. (2006) further represent a culmination of persistent challenges experienced by age-at-death estimation techniques. Consistent with the review conducted by Buckberry and Chamberlain during development (2002), Falys et al. (2006) found that the composite scores of trait expressions were generally and positively correlated with known chronological age. Building upon the idea that certain individual features have a greater indication of age when compared to others, Falys et al. (2006) suggest that there were only three discernible age-related stages that could be statistically validated. Combining components of the seven stages Buckberry and Chamberlain (2002) suggest, Falys et al. found that only three stages, with a mean age of 38.6, 52.3, and 65.7, have significant age differences. Operating as a direct comparison to the seven stages, the new stages proposed by Falys et al. (2006) show that middle-aged individuals expressed a great deal of individual variation – and thus, significant overlap when attempting to quantify stage and age. This method seeks greater certainty but does so with a sacrifice of precision. Although Falys et al. (2006) credit Buckberry and Chamberlain (2002) with the ease by

which the composite score is averaged from the independent scores, the authors found that it only made significant contributions to the already existing age estimation technique for individuals between 50 and 69 years old (Falys et al., 2006).

Although the study by Falys et al. (2006) confirmed the replicability and validity of a composite age estimates on reference collections, an adjustment of age categories was suggested. In looking at the evolution of age estimation techniques, Lovejoy et al. (1985) argued, quite optimistically, that age estimations could be made in five-year intervals. In reality, not even the combination of two composite score ranges at five-year increments, could encompass the amount of morphological variation apparent in the auricular surface within an age range. The age ranges, therefore, were too specific to meet the supposed idealized representative morphologies of a certain age. Conversely, the age ranges that Buckberry and Chamberlain (2002) offered were too numerous. Thus, reducing the number of stages by collapsing them into larger ranges assigned to each stage is more representative of actual age variation. Of the three age ranges identified by Falys et al (2006), the median ages correspond to the greater number trend - Stage I representative of a median age of 36, Stage II representing a median age of 55 and Stage III representing a median age of 65 (Falys, et al., 2006). This suggestion effectively circles back to the crux of age estimation challenges. As an estimation, and in order to be accurate, the range must be particularly vast. The larger the ranges, the less anthropologically valuable they are.

Falys et al. (2006) worked to mitigate the approaches that were either too specific or too broad by aggregating the composite scores, “allowing for a distinction between

young and older individuals, whereas a group of intermediate composite scores represents rather widely spread documented ages" (Falys et al., 2006, pg. 511). In specificity, accuracy was sacrificed in order to capture a close approximation of actual age at the cost of statistical confidence. If too broad, precision in age was sacrificed to capture the array of possible ages. Comparatively, of the seven age ranges that Buckberry and Chamberlain proposed in 2002, there were only significant differences in age between stages 2 and 3, 5 and 6, and 6 and 7. Even so, Falys et al. (2006) agreed that it is conducive to operate with age ranges that are discrete from one another, even if it sacrifices the specificity of actual age ranges. Suggestions for the inclusion of subgroups is unfounded, considering the expansive amount of variation within a range, much of which is qualitatively descriptive, but not realistically or quantitatively accounted for.

In conclusion, the research supported even the earliest scholarship on age estimation by suggesting and confirming that a young age range (around 16 to 26 years) exhibits the lowest amount of variation, and therefore offers the most accurate snapshot of fairly developmental features that unfold, prior to the degenerative forces that tend to be somewhat more unique to the individual (Falys et al., 2006). In addition, the techniques and ages that correspond to age have historically been plagued by a disconnect between accuracy and precision, which appear for consideration by Milner and Boldsen (2012).

AGE-AT-DEATH ESTIMATION BY TRANSITION ANALYSIS

The history of methodological developments, refinements, and rapprochements that have contributed to age-at-death estimations have historically been plagued with recurring challenges as described above. These challenges extend beyond a consideration of the features that should be analyzed and scored. Challenges emerge with population variability in age-related degeneration, both within the informed prior and the sample that is being scored. In addition to the inherent issues prompted by the comparison of two (or more) unrelated populations, age estimates tend to sacrifice precision for accuracy when age ranges are expansive. Conversely, precision of age tends to not have an acceptable accuracy rate when tested for validity.

Transition analysis is one of the most recent methods used in osteological and paleodemographic age estimation. Based upon the Bayesian analysis of ordinal scale measurements, this method received its name from what it infers - "the timing of transitions from one stage to the next" (Boldsen et al., 2002, pg. 74). For some in the field, this method represents a method that can transcend the long-established roadblock to lumping older individuals in a 45+ or 50+ age category.

The technique depends upon the ordered transition of important elemental features, in this case the development and degeneration of the sacroiliac joint, the pubic symphysis, and the fusion of cranial sutures with age. Variability in the appearance of development and degeneration undoubtedly exist, but the trajectory is fixed. Of the scorable features, the pubic symphysis is by far the most accurate. In fact, its accuracy

rate alone was close to the calculated accuracy average of all three indicators (Boldsen et al., 2002). The scoring procedures, mechanics, and mathematical basis of practicing and applying transition analysis are described in the Materials and Methods chapter later in this thesis.

There are four known analytical difficulties that arise when estimating adult age-at-death. These include: (1) how to represent the unavoidable (and often quite large) uncertainty involved in age estimation; (2) avoidance of age mimicry (influence upon a sample of unknown age distribution by the age composition of the reference sample); (3) questions of how to combine skeletal indicators of age, and finally; (4) how anatomical features should be scored in a way that captures any and all morphological variation that is informative to age (Boldsen et al., 2002). In order to address these problems in the development of transition analysis, the authors admittedly addressed the fact that there is an unknown amount of error that is present in each individual. The solution, as it turns out, is just as unique as the individual the technique considers. Rather than building age ranges that incorporate an assumed rate of error through expansive parameters, the technique is built upon a "particular suite of traits and quality of preservation" (Boldsen et al., 2002, pg. 76). Rather than past estimates that have been ineffectively been applied to the masses, an age probability here can be "calculated separately for each skeleton and for every value of *a"* in which *a* is age (Boldsen et al., 2002, pg. 76).

Such probability density is dependent upon the observable skeletal characteristics that individually correspond to age ranges. In this sense, the test provides an age range that is flexible enough to consider the probability of death at a certain age, given the

morphological characteristics associated with degeneration (Boldsen et al., 2002). Instances of "well behaved" characteristics, or those elements which correspond favorably to one another, will result in a more narrow and certain age range. Elements that score to varying levels of degeneration will result with an increased age range, in order to account for the range of compounded error (Milner and Boldsen, 2012). By understanding the realities of conditional independence, a combined likelihood function is created by multiplying the stage likelihoods associated with each trait element (Boldsen et al., 2002).

Transition analysis can also be used for multiple, single and fragmented elements, but depend on an understanding of conditional independence. This means that the stage and rate of transition to features of the *os coxae* and cranium occur independently to one another but are linked by a common factor - increasing age. As stated by Boldsen, there is no other factor that acts on all three anatomical units in quite the same way. Because of the technique's flexibility, it is extremely useful for the many archaeological contexts that do not have excellent preservation or known associations between elements (Boldsen et al., 2002).

APPLICABILITY AND ACCURACY

Transition analysis has been validated using multiple geographic and temporally unique comparative collections, all of which have known age-at-death information. As with all other techniques, there are certain limitations associated with the resulting age

estimation ranges along with weaknesses associated with developed and applied scores (Hagelthorn et al., 2019).

Of the elements incorporated in age-at-death estimations, cranial scores are by far the most inaccurate. In fact, suture closure is so variable that they provide little knowledge in the way of age estimates (Milner and Boldsen, 2012; Singer, 1953; Brooks, 1955; McKern and Stewart; 1957). They often skew age estimations toward more youthful estimations when included in the mathematical analysis. Their function is mostly limited to developmental, rather than degenerative forces.

In use, transition analysis very closely resembles in conceptual terms the techniques developed by Lovejoy et al. (1985) while also extending the range of significant tendencies to underestimate age from 40 to 60. Quite boldly stated and in the same theme as cranial sutures, the singular use of the auricular surface of the *os coxae* contributes very little once it no longer corresponds to a certain identifiable developmental or degenerative stage (Milner and Boldsen, 2012). Much as cranial suture scores, when estimates are applied above the 60-year mark, the individual scores of the auricular surface tend to draw the composite score (and age) downward.

Milner and Boldsen (2012) suggested that the pubic symphysis, having been long studied in age-estimation, produces better results than the auricular surface, although a lack of preservation tends to become an issue in many archaeological settings. In independent use, estimated age ranges tend to be more comparable, if not more precise, than the ages gathered when using the Suchey-Brooks technique alone (1990).

When scores are used in tandem, transition analysis results in the most age discrepancies between middle-aged and older individuals. Typically, these discrepancies manifest between the age ranges produced by the cranial sutures and the *os coxae*. Reasoning for these discrepancies are rooted in the lack of middle and old stage-dependent characteristics and selective mortality of the sample, which may have a predilection for younger individuals. It performs well in the young and extremely old age categories, based on the predictable rates of development and degeneration (Milner and Boldsen, 2012).

The application of transition analysis on populations that differ in composition or origin from the informed prior used to develop the technique, prove favorable when scores for the various elements were used in combination. As such, tests of transition analysis's applicability, when using ADBOU software, were conducted on the Pretoria Bone Collection and the heterogenic South African Mixed Ancestry population by Jooste et al. (2016) and by Hagelthorn et al. (2019), respectively.

Working with archaeological and forensic contexts from the Pretoria Bone Collection in South Africa, Jooste et al. (2016) report that transition analysis produced imprecise age-at-death estimates. Acknowledging the bias introduced by the incorporation of cranial scores in the multi-element analysis, an attempt to remedy the age estimates resulted in the removal of cranial scores. Removal of the cranial scores rectified the inaccuracies of age estimation, although it also removed the highest precision range from analysis. Here, the auricular surface of the *os coxae* performed the best in reference to known age. The pubic symphysis provided the second-best

representation of age, which the authors note is in direct disagreement with Milner and Boldsen's suggestion that the pubic symphysis would provide the most accurate age-at-death estimates (Jooste et al., 2016; Milner and Boldsen, 2012). Although statistical evidence supports the disconnect between the population upon which transition analysis was built and its application to geographically distinct populations, the difference of calculated accuracy of an element is very intriguing.

The overarching constraint of accurately estimating age was embedded in the influence of population variability, which did not translate between the target and subject samples and possibly aided in interobserver error. In addition to the population variability, the authors suggested that a mortality distribution that better reflected the African population might mitigate the tendency for scoring procedures to skew towards a certain age (Jooste et al., 2016).

Unlike Jooste et al. (2016), Hagelthorn et al. (2019) found that estimated ages gathered for the South African Mixed Ancestry population corresponded positively (with a Pearson correlation coefficient of 0.58) to the known ages of the individuals. Specifically, Hagelthorn et al. (2019) discovered that the auricular surface scored the highest in accuracy, while the pubic symphysis was argued to be the least accurate. The disconnect between element accuracy and associated stages, developed from Euro-American individuals and applied to geographically discrete populations, have important implications for the swath of human variability expressed within an element and how that element should be employed in transition analysis. More importantly, the argument for applicability of transition analysis on geographically discrete populations should provide

fuel for the development of age ranges from collections with known age-at-death that vary temporally and geographically (Hagelthorn et al., 2019).

In another review, Godde and Hens (2015) reviewed the applicability of transition analysis when applied to historic Italian populations. Oriented to the comparison of the Forensic and Rostock approaches of transition analysis, the study effectively illuminates the differences between the target sample, from which the age ranges are derived, and the resultant age estimations. For instance, the Rostock method, which is a strategy to estimate the distribution of age-at-death of the target population before that of a single individual, is built upon age indicator variation in three samples. In true form, the three samples would be: a sample from which transition ages are gathered from transition analysis, a prior sample used to inform hazard parameters, and the target sample that has newly developed age estimates. Despite the lack of precision, this method is more applicable to a wider array of populations. Conversely, the forensic method involves only two samples: the informed prior sample and target sample. Because the age ranges and associated age-related characteristics are dependent on a fewer number of samples and the ages-of-transition are generated from the target sample, the ages associated with scores tend to be more precise. In addition, the forensic method is better suited to create age estimations from populations that have similar morphological alterations and mortality distributions. The utility of the forensic method is rooted in the reconfiguration of age ranges from scorable age-related characteristics, derived from and specific to a geographic region and temporal range. The creation of a regional target sample prior to

application to the subject sample is paramount to the use and accuracy of the forensic method (Godde and Hens, 2015).

The analysis of techniques yielded partial support for the hypothesis, which stated that the forensic method would result in more accurate age-at-death estimates. In light of the mixed data, the authors were careful to warn that the success rate of the Rostock method could be a byproduct of the already increased age ranges. Despite this consideration, both tests provided more accurate age estimations than the single application of the Suchey-Brooks method (Godde and Hens, 2005).

Milner and Boldsen more recently (2012) argued that importance of transition analysis is dependent upon the potential it holds to express a population's specific distribution of age-at-death as applicable to many archaeological skeletal assemblages. The authors believed it would prove less useful for independent age estimations typically undertaken in forensic contexts. In addition, transition analysis represents the potential for age-at-death estimation to transcend truncated age ranges followed by open-ended possibilities. It has effectively shown more concise confidence intervals among the exceptionally old, which suggests that advanced age does not produce entirely random and unidentifiable degenerative morphological changes (Milner and Boldsen, 2012).

CONCLUSION

This chapter outlined the evolution of adult osteological age-at-death estimations in biological anthropology along with the many constructive developments and perennial

challenges. Because age-at-death estimations are dependent upon the intersection of biological and cultural factors (many of which may never be fully known), the age ranges which are produced are approximations that attempt to mitigate modeled rates of development and degeneration and do so in light of a systematically complex amount of human variability. Further building upon the complexities of human variability, age mimicry from the samples that inform the technique cast another layer of complications.

Despite the overlapping and intertwined series of challenges that exist in age-at-death estimations, many techniques have emerged and contributed to the corpus of knowledge that informs age estimation. Most important to the work undertaken in this thesis, advancements in transition analysis have extended discernible morphological changes to older individuals, who were overwhelmingly previously clumped into an age category of 50+. In addition, transition analysis has been developed to be flexible enough for use in fragmented and otherwise incomplete archaeological contexts. This development is vital for the consideration of secondary burials in a way that promotes an advancement of fundamental, paleodemographic knowledge, addressed in the following chapter. Such paleodemographic perspectives serves as the foundation stone for further bioarchaeological inquiry, especially in a domain that has limited theoretical frameworks.

CHAPTER FIVE: MATERIALS AND METHODS

This chapter presents the materials and methods used in this study of the human remains from the Baum Site, and the methods that are best suited to support bioarchaeological inquiry for complex, commingled burials. In order to understand the rationale behind the incorporation of these methods, a brief history to recap method limitations and the incorporation of these remains in previous studies. Paleodemographic reconstructions of commingled remains, such as those excavated from the Baum site, have largely been avoided due to the dearth of methods and theory that can be applied to commingled remains. The process of pair matching long bones appears tedious, with seemingly little reward beyond a confirmation or reconfiguration of what has been previously estimated through an application of Minimum Number of Individuals (MNI) analysis. In addition, age-at-death estimations have a reinforced value as a covariate in groundbreaking theoretical frameworks that can be applied to individuals, such as Survivorship Analysis or Developmental Origins of Heath and Disease (DOHaD). In light of these nihilistic outlooks that incorporate the analysis of commingled secondary burials, this thesis addresses the development of paleodemographic reconstructions that can later inform identity, agency, and marginalization.

Past research of the Baum site has overwhelmingly considered components of the burial that reflect biological distance to other known settlements within the region

(Kakaliouras, 2003; Killgrove, 2002; Weidner, 2018). Paleopathological analysis has also incorporated some elements of the Baum site, especially when considering the "health" of indigenous peoples prior to European contact (Hutchinson, 2002; Hutchinson, 2006; Souther, 2014, Vasalech, 2011).

Prior to this thesis research, paleodemography of the Baum site was limited to estimates of the Minimum Number of Individuals and a broad categorization of individuals as either "adult" or "juvenile." This was largely due to the complex nature of disarticulated and fragmented burials, and the absence of methods that could be applied to elements without known associations. In addition to limitations involving methods, the complexity of element placement and element loss has resulted in a dearth of applicable theory, which is an increasingly important aspect of interpretation and the practice of bioarchaeology.

The introduction of relatively new and more precise paleodemographic techniques made the project favorable to arriving at results that corroborate the early estimations of the number of individuals represented and introduce age ranges for the first time. The author decided to explore the paleodemographic composition of the Baum site as a research topic, considering the promising results of case studies that reflected conditions close to that of the Baum site. Homing in on the scope of each paleodemographic component, various points of interest emerged. These included (1) how the results of the Most Likely Number of Individuals technique compared to estimated Minimum Number of Individuals, (2) if age-at-death distributions could illuminate inclusiveness of the

communal burial, and (3) whether age-at-death estimations would be impacted by the incorporation of cranial scores.

Theoretical implications of assessing the ossuaries, discussed in a later chapter, assume a cautionary application of early life history models, DOHaD and Survivorship Analysis of the few individuals that have known associated elements. This is introduced in light of the overwhelmingly atheoretical background of secondary burials, and with tacit knowledge that these associations are dependent upon individual identifying pencil markings – all of which reflect field identification numbers or letters. Some associations are held together by this primary line of evidence, considering the disassociation in curatorial contexts.

Overarching the punctuated instances of primary or bundled burial, the utility of a paleodemographic reconstruction is, in and of itself, an acknowledgement of individuals that no longer have individual identity, but an identity that is centered on group anonymity. Paleodemographic reconstructions of representation and age estimates, in this sense, reallocate a level of agency and reinforce the visibility of the group – a group that has mostly been ignored in theory and method. Discussion brings into focus the liminal agency of the group that exists by not having an empowered federal or state representative.

The purpose of this chapter is to outline the techniques used to answer the research questions and inform the theoretical frameworks briefly mentioned above and elaborated on in a later chapter. The series of steps described are in the order the author thought most effectively and efficiently suited data collection and test performance.

Most Likely Number of Individuals

Over the course of five months, research was conducted on the remains of the Baum site at East Carolina University in Greenville, North Carolina. The remains that were employed in this study were originally interred at what colloquially became known as the Baum site, which was named after the family that owned the land for multiple generations. Located in Currituck County and on the cusp of the turbulent Atlantic Ocean and in immediate vicinity to the Currituck Sound, the remains found their way into the Bioarchaeology Lab through a series of urgent salvage excavations. Limited by time, financial resources, and the weather, the team of state archaeologists from the Office of State Archaeology and archaeologists from East Carolina University made an effort to capture the complexity of the burial in situ, while also attempting to maintain the burial's integrity despite the climate (Phelps, 1980). Once excavated, nearly all the remains were cleaned and placed in museum grade sealable plastic storage boxes. Incorporation of the remains into other research or theses projects resulted in some remains, mostly dentition and "juvenile" remains, being repackaged in acid free resealable bags.

Due to the erosion of the site, Feature 1 Ossuary had eight *os coxae* fragments that were scorable for transition analysis. Burial 1 incorporated 17 left humeri, 20 right humeri, 34 left femur bones, 34 right femur bones, 31 left tibiae, and 33 right tibiae. There were 48 total crania or cranial fragments, 32 of which were scorable in Burial 1. In addition, there were 84 fragments of the *os coxae*, and 81 of which were scored. Burial 5 incorporated 15 right femur bones, 15 left femur bones, 12 right humeri, 9 left humeri, 15 right tibiae, and 11 left tibiae. Of the 25 cranial fragments, 11 were scorable. There were

26 recognizable fragments from the *os coxae*, 25 of which were scorable. Burial 7 included 34 right femur bones, 25 left femur bones, 24 right humeri, 28 left humeri, 22 right tibiae, and 20 left tibiae. There were 28 crania total, and 21 were scorable. Burial 7 also incorporated 44 *os coxae* fragments, all of which were scorable. Burial 8 was highly fragmented, with elements that were reduced to unmatchable and unscorable portions.

In order to work with the remains in a fashion that was conducive to data entry and later recall, if necessary, the author worked systematically to gather data from elements of a single burial. Beginning with Burial 8, which was comprised of bone fragments that only composed one box, the author worked through Burial 8, Burial 7, Burial 1, Burial 6, Burial 5, a series of remains from primary burial contexts, and remains gathered from the beach. Primary burials and skeletal remains with known associations were notated in the digital copy of notes, as well as the drawings for quick reference. Remains from the beach scatter had no provenience and were therefore treated as an independent source. Burial 1 and Burial 5 had elements with known associations, which were then subdivided into categories based on marked identifiers and corresponding crania.

Based on the work that outlined the technique (Adams and Konigsberg, 2004) and tests of robusticity and dispositional survivorship (Willey et al., 1997), it was determined that the femur bone, humerus, and tibia would be used for pair matching activities. This decision was made based on the guidance that suggests these larger, more robust elements tend to preserve better in the archaeological context. In order to keep the data recall manageable for each burial, the elements that were used were drawn and marked

with missing portions, diagnostic features (such as the presence of epiphyseal lines), taphonomic alterations to the bone, and portions that appeared to have pathological alterations. In addition, each element received a code that corresponded to a master spreadsheet in Google Docs that recorded the length of the long bone (if complete) to the nearest millimeter, and detailed notes on gross morphological appearance. Length was recorded to aid in the pair-matching process, based on the knowledge of strong correlations between bi-lateral long bone length when development was not inhibited by infection or other identifiable developmental delays (Adams and Konigsberg, 2004).

Once the elements were recorded for completeness, taphonomic damage, pathological alterations, and other diagnostic characteristics, the author identified and removed long bones from their storage boxes and placed all left and right elements on the large working surface in the lab. Once again following the guidance of Adams and Konigsberg (2004), left elements were considered the "capture" group, which meant the right were considered the "recapture" group. Or more simply, a single left element was compared to all right options of the same element.

It should be noted that one of the major drawbacks of MLNI protocols involves the subjective nature of pair-matching. Once the empirical evidence of diagnostic bi-lateral correlations was exhausted, such as length or phase of epiphyseal fusion, it fell to the discretion of the researcher to estimate matches. It is also important to note that in some cases, diagnostic correlation indicators were missing, such as in the cases of fragmented remains. In any regard, the observer was careful not to enthusiastically match pairs without the concurrence of multiple lines of evidence, including the appearance of

certain features and robusticity. It was a conscious effort to not over-match what could not be later explained or reproduced.

Once pairs were successfully made, although cautiously so, the corresponding cells in the spreadsheet were marked with corresponding colors. The drawn documents were stapled for ease of use later. At this point, a quick comparison of Minimum Number of Individuals and Most Likely Number of Individuals began. This was followed by a more engaging analysis of pair-matching probability, as outlined in Lyle Konigsberg's open access R scripts (Konigsberg, 2019).

In order to run analyses in R, it is recommended that a goodness of fit test is conducted, which tests the difference between the observed and expected value. In the case of MLNI analysis, it considers the probability of having variables that are independent to one another. The null hypothesis states that there is no relationship between two variables, and the alternate hypothesis states that there is a relationship between the two variables. A significant result, or a value that is less than an alpha level (a) of 0.05 indicates statistically significant difference between the variables. In this case, the null hypothesis of variable independence is supported. A result that is greater than the alpha (a) can be understood as providing support for the alternate hypothesis, which means that there is a statistical chance that the two variables in question have some sort of relationship. When applied to MLNI, a non-significant result indicates that when tested as a multi-element estimator, there is a good chance of producing unbiased results (Adams and Konigsberg, 2004).

The R-script, written to be used for MLNI calculations, produces information on the Highest Density Regions (HDR) and the Recovery probability (r). HDR's are used to show the probability of occurrence (N), which is dependent upon multiple values – Left, (L), Right (R), and Pairs (P). HDR's can be graphed to show values above a manipulated threshold, typically set at a 95% probability. The Highest Density Region then becomes the values above that threshold. The equation for the complete likelihood distribution can be written as:

$$\Pr(N|L,R,P) = \frac{L!\,R!\,(N-R)!\;(N-L!}{(L-P)!\,(R-P)!\,(N-L-R+P)!\,(N+1)!\,(P-1)!}$$

$$= \Pr(P|L,R,N) \times \frac{P}{(N+1)},$$

where Pr(N|L,R,P) is the probability of getting pairs after drawing lefts (L) and right (R) from N individuals.

MLNI is dependent upon the successful pair matching of elements. It seems redundant, but the recovery of those elements is paramount to the technique. In the more simplistic MNI calculations, the recovery probabilities of elements are unknown. The recovery probability is the likelihood of recovering certain elements while assuming that N number of individuals would have *Nr* lefts, *Nr* rights, and thus, Nr^2 pairs. The N number of individuals represented within the assemblage is often unknown, thus warranting techniques such as MLNI. What MLNI offers is a recovery probability built upon the number of single Left elements (L), number of single Right elements (R), and the number of Pairs (P) that are deduced from the single groups. It offers the closest

rendering of statistical recovery, given the successful (or not so successful) pair-matches made (Adams and Konigsberg, 2004).

The recovery probability can be calculated with the equation

$$\hat{r} = \frac{2P}{L+R}$$

The standard error can be calculated with the following equation

$$\text{s.e}(\hat{r}) = \left[\frac{(\hat{r}-1)^2(\hat{r}-2)^2\ \hat{r}^2}{\hat{r}^2(L+R)(3-2\hat{r})+2P(2-6\hat{r}+3\hat{r}^2)}\right]^{1/2}$$

Age-at-Death Estimation: Transition Analysis

In order to understand the age-related aspect of paleodemography, the author decided that Transition Analysis would be the most appropriate and accurate method for age-at-death estimation, considering its accuracy and applicability to single elements. This was especially important when studying a secondary burial, when crania and *os coxae* sometimes have no known associations. Previous iterations of age-at-death estimations, including the techniques developed by Todd (1920), McKern and Stewart (1957), Lovejoy et al. (1985) and J.M. Suchey and S.T. Brooks (1990) were much more limited in both the accuracy of the estimates, even going so far as to place age in the wide-open category of 50+.

The application of transition analysis includes scoring cranial sutures and pubic symphyses at five points and scoring the auricular area at nine points. Using the Transition Analysis manual, the author was able to efficiently and effectively record all available scores. Crania with known associations to *os coxae* were noted, so that analysis

with the widest breadth of evidence could be performed. Cases of isolated elements were also scored for independent analyses. The ability for Transition Analysis to be used, albeit with a greater range of possible ages, with isolated elements is truly a strength for the underrepresented methods applicable to commingled and secondary burials (Boldsen and Milner, 2012).

The 19 scorable points each correspond to a level of development, such as suture closure, and degeneration, such as the course granularity of the pubic symphysis that form from previously well-defined billows. Flexible enough to identify that a single score will not encompass the total range of reflected change, Transition Analysis incorporates a minimum and maximum range. Expanding on the possible age range, minimum and maximum scores are important to include to capture the process, the transition, of elements from one discrete phase to the next (Boldsen and Milner, 2012).

The corpus of material that operates as an informed reference to ages and morphological change is addressed by Boldsen et al. (2002). In scenarios where age is estimated in a forensic context, age is based on development and degeneration associated with senescence can be pulled from contemporaneous individuals of known age-at-death. In this sense, an informed prior are the data that inform contemporaneous trends in the morphological change of elements that are conditional to age but impacted by time and location. Because this analysis is performed on an indigenous population, it is better to use data from a generalized age-at-death distribution model of mortality, known as a uniformed prior. The point estimates that result at the 95% confidence level are a single value that emerges from the compiled data of the uniform prior. The use of an informed

prior with unwarranted evidence to support a known relationship between the analyzed individual and the reference information "can create a tautological circle" of data that is biased towards parameters that are more relevant to a certain population (Boldsen et al., 2002, pg. 78).

Once scores were completed, the ADBOU software platform was used to generate age ranges. Developed from populations of known ages and scorable age indicating elements, three options of origin are offered – black, white and unknown. Because the remains from the Baum site are indigenous peoples, the unknown category was selected. Although this arguably blurs the age ranges further, it is important to note that an improper use of an informed prior would result in the age output to mimic the reference sample. Cultural constructions of race aside, the use of either white or black presets and the reference samples that they are based on, is of no greater morphological advantage than the juxtaposed use of "unknown" in the software (Boldsen et al., 2002)

In addition to origin, sex estimates are gathered from each element when indicators are present. Sex estimation followed closely to the best practices outlined in Buikstra and Ubelaker's (1994) protocols, including the morphological indicators of the pubic symphysis, the morphological indicators of the sciatic notch and preauricular sulcus, and the sexually dimorphic cranial features (Phenice, 1969; Buikstra and Mielke, 1985; Milner, 1992; Acsádi-Nemeskéri, 1970). In cases where multiple sex indicators were available, the results were averaged to help determine the likelihood of the individual falling within the realm of likely male, likely female or ambiguous. In some instances, sex estimates were limited to one indicator. Unless a strong likely male or

likely female score existed, the sex was listed in notes as ambiguous or unknown in ADBOU.

To compile estimated age based on multiple elements, it is necessary to acknowledge the complexities of estimating age from the juxtaposed rate of morphological change of three elements. Consideration of this limitation resulted in a discussion of conditional independence, which means that the auricular surface of the *os coxae*, the pubic symphysis, and the cranial sutures are independent of one another. There is a known correlation, however, between the three elements and age. The three elements do not depend on one another but are rather independently affected (at different rates of transition and accompanied morphological changes) by advancing age (Boldsen and Milner, 2012; Boldsen et al., 2002). Although conditional independence is understood between the three elements, it cannot be assumed that the several parts of a single anatomical unit are conditionally independent when the condition is age.

The data that emerge using ADBOU are range of probabilities that indicate the probability of transition at a certain age. These are based upon logistic regression models that quantify the characteristics that change from one stage to the next. The likelihood curves from each independent element, those gathered from the cranial sutures, the pubic symphysis and the auricular surface, result in age estimates that are obtained by combining the likelihood distributions of all three anatomical units. The point estimate provides a mean age at a selected level of confidence, the standard being set at the 95% range (Boldsen and Milner, 2012).

The probability, written as Pr($a|c_j$), can be understood as "the probability that a skeleton died at age a given that it has characteristics c_j, where c_j is the set of skeletal traits observed in the j-th skeleton" of the sample (Boldsen, 2002, pg. 76). In the most straightforward understanding of interactions between age and morphological characteristics, an application of Bayes's theorem, age, a, should be derived from a set of scorable characteristics, c_j, through regression analysis. As described previously, estimated age based on juxtaposed characteristics will tend to be skewed towards the reference sample, which may have an unequal distribution of ages. In order to remedy the age mimicry, characteristics, c_j, need to be regressed upon age. Although this tends to be less sensitive to the distribution of the reference sample, it does not estimate an age. It estimates morphological characteristics, given a certain age. Despite this, it operates as a "weight function," if derived from a comprehensive reference sample (Love and Müller, 2002; Boldsen, 2002, pg. 77).

At this point, Pr($a|c_j$) can be estimated from the regression analysis gathered from Pr($c_j|a$), coupled with the age-at-death distribution of the sample being studied, $f(a)$. As an application of Bayesian theorem of interactions based on relationships, $f(a)$ could also be understood as the reference samples distribution (Boldsen, 2002). This equation can be written as:

$$\Pr(a|c_j) = \frac{\Pr(c_j|a)f(a)}{\int_0^\infty Pr(c_j|x)f_{(x)dx}}$$

This equation produces the probability that an individual selected at random from the population in question is exactly at age *a*.

CONCLUSION

The purpose of this chapter was to present the methods used to conduct the paleodemographic reconstruction of the Baum Site. This included addressing the known constraints of the chosen methods. In summary, the methods are capable statistical estimators of the number of individuals represented within the burial and the ages in which the individuals died. These methods of estimation are increasingly powerful considering the scope of successful application, considering the limitations introduced by the collection itself. The results of the analysis are presented in the following chapter.

CHAPTER SIX: RESULTS

This chapter presents the data gathered from the human remains excavated at the Baum Site (31CK9). Due to the commingled and fragmentary nature of the remains within the ossuaries, MLNI and transition analysis techniques were employed to most directly inform paleodemographic reconstruction. In turn, this reconstruction serves as a foundation to further develop and evaluate the overarching archaeological and historical contexts that immediately or tangentially resulted in the creation of the site and its funerary components.

In order to report the results of the analysis, this chapter is organized in two sections. The first section presents MLNI data and presents the estimate for the number of individuals within the three documented ossuaries. The second section addresses the age-at-death estimation using transition analysis, from all scorable elements from the Baum Site.

MOST LIKELY NUMBER OF INDIVIDUALS

The goal of this research is to estimate the number of individuals represented within the fragmented and commingled secondary burials. The data are presented in a

matrix that identifies the number of left and right elements for the humerus, femur bone, and tibia. The number of successful pair matches are included for each individual element. The Highest Density Regions (HDR) outline the parameters of possible number of individuals within the ossuaries, at a threshold close to, but not exceeding 95%. The calculated MLNI is between the parameters established by the Highest Density Region approaching the 95% threshold. For comparison, the Minimum Number of Individuals (MNI) is identified by discerning the most numerous independent element. Finally, each table identifies the recovery probability and standard error of each element. This is a valuable statistic, as it indicates how likely it was that each element was discovered in the archaeological context.

In addition to the matrix that identifies the number of individual elements, the number of successful pairs, the HDR, and the MLNI estimate, the calculated MLNI is shown at the highest possible HDR. Finally, a chi-square Goodness of Fit test indicates if the test is a valid estimator of the number of individuals likely within the ossuary.

Burial 1

Burial 1, which was the first intact ossuary encountered at the Baum Site, was excavated in 1973. Based on the associated sherds and grave goods, it is likely that this burial occurred during the Late Woodland period.

Table 6.1. Results of analysis of the Baum Site (31CK9) Burial 1

a. Element counts and estimates of N

Element	Lefts	Rights	Pairs	Max (L,R)	L+R-P	MLNI†	%HDR
Humerus	17	20	9	20	28	29,36,57	94.7%
Femur	34	34	20	34	48	47,57,67	94.2%
Tibia	31	33	19	33	45	50,53,71	94.4%
Overall				34		50,54,61	94.6%

b. Estimations of Recovery probabilities (r) and their standard errors

Element	r	s.e.
Humerus	0.4864	0.1011
Femur	0.5882	0.0709
Tibia	0.5938	0.0709

Table 6.1 MLNI† - The first number in the column represents the lowest value for the highest-density region (HDR), the second number represents the MLNI, and the final number represents the highest value for the HDR. Column to the right gives the HDR% closest to the 95% value.

Table 6.1 presents the total number of left and right elements, the number of successful pairs, the Minimum Number of Individuals (MNI) represented by Max (L,R), the estimated Most Likely Number of Individuals at the indicated Highest Density Region for Burial 1. The estimated MNI, based on the max number of independent elements, is 34 individuals. This estimate is based on the number of left and right femur

bones. When coupling the MLNI estimates of all features, the MLNI is calculated at 54 individuals, at a 94.6% Highest Density Region.

In addition to the calculated MLNI, the recovery probabilities indicated in Table 6.1 represent the probability that an element made it initially into the archaeological context. Of the long bones considered in MLNI analysis, tibiae had the highest recovery probability at approximately 59%. The tibia is followed closely by the recovery probability of the femur bone at approximately 58%, with the humerus trailing last at approximately 49%. Figure 6.1 reflects the calculated MLNI within the HDR region.

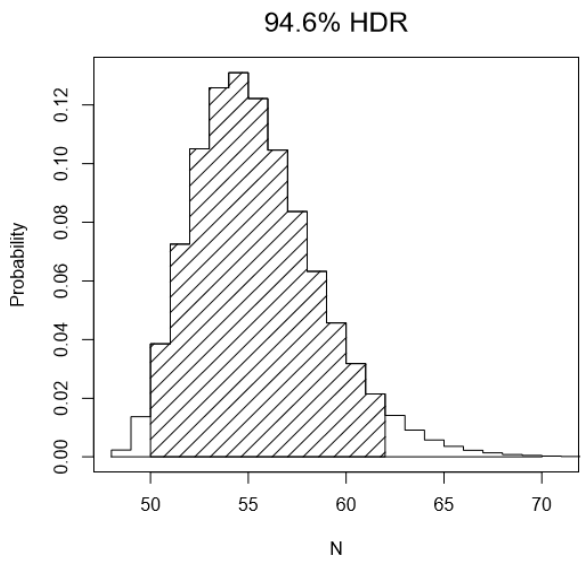

Figure 6.1. Burial 1, Highest Density Region (94.6%) of all three components.

Burial 1	
chi-square	3.94
DF	2
p	0.14

Table 6.2. Burial 1, chi-square, Degrees of Freedom, and the p-value of MLNI analysis.

Table 6.2 represents the chi-square, or Goodness of Fit values for the MLNI calculations. This statistic estimates the consistency of the estimator tool and assumes independence in the recovery of elements. The Goodness of Fit values of 54 individuals within Burial 1 is 3.94, with two degrees of freedom results in a probability value equal to 0.14. Because the probability value is greater than the critical value at the 0.05 alpha (*a*), the multi-element estimation tool has a reasonable chance of remaining unbiased, which means that the MLNI values are likely an acceptable estimation (Adams and Konigsberg, 2004).

Burial 5

Burial 5, which was heavily eroded by the shifting shoreline, was excavated in 1980. Despite the erosion, the ossuary maintained enough structure to preserve a single intact burial that was designated, as Burial 5A in excavation records, and it was found at a higher stratigraphic level.

Table 6.3. Results of analysis of the Baum Site (31CK9) Burial 5

a. Element counts and estimates of N

Element	Lefts	Rights	Pairs	Max (L,R)	L+R-P	MLNI†	%HDR
Humerus	9	12	5	12	16	16,20,41	94.9%
Femur	15	15	3	15	27	42,63,77	94.0%
Tibia	11	15	3	15	23	34,47, 71	90.3%
Overall				15		33,43,66	94.8%

b. Estimations of Recovery probabilities (r) and their standard errors

Element	r	s.e.
Humerus	0.4762	0.1345
Femur	0.2	0.098
Tibia	0.2307	0.1099

Table 6.3. MLNI† - The first number in the column represents the lowest value for the highest-density region (HDR), the second number represents the MLNI, and the final number represents the highest value for the HDR. Column to the right gives the HDR% closest to the 95% value.

The estimated MNI of Burial 5 is 15 individuals, which can be derived from either the femur bone or the tibia. Conversely, the estimated MLNI score is nearly three

times this score, at an estimate of 43 individuals at the Highest Density Region of 94.8%. The highest density region is depicted in Figure 6.2.

Burial 5 has a much lower recovery rate than Burial 1. This is illustrated by the recovery probability results, which are derived from the number of left and right elements and the number of successful pair-matches created from this sample. The humerus demonstrated the highest recovery probability at approximately 48%. This recovery probability exists despite only having five successful pair matches. Conversely, the femur bone has a 20% recovery probability, with only three successful pair matches.

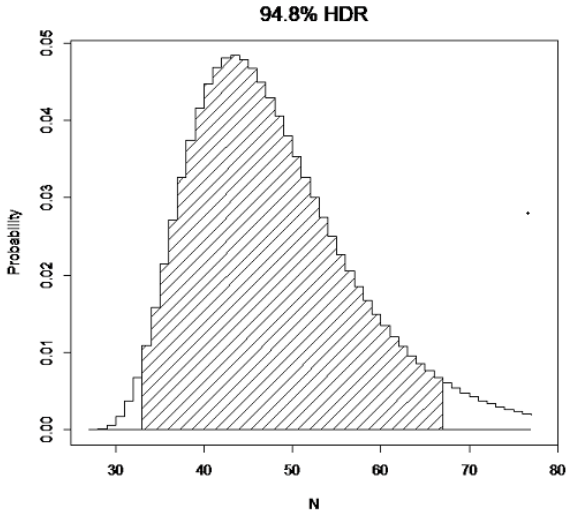

Figure 6.2. Burial 5, Highest Density Region (94.8%) of all three components.

Burial 5	
chi-square	6.89
DF	2
p	**0.032**

Table 6.4 Burial 5, chi-square, Degrees of Freedom, and the p-value of MLNI analysis. Significant differences are bolded.

The disruption between the calculated MNI and MLNI is reflected in the chi-square statistic. Notably, the p-value falls below the alpha (*a*) of 0.05, as represented in Table 6.4, which indicates a statistically significant result. Because of this significant result, it is likely that the HDR ranges are too narrow (Adams and Konigsberg, 2004).

Burial 7

Table 6.5. Results of analysis of the Baum Site (31CK9) Burial 7

a. Element counts and estimates of N

Element	Lefts	Rights	Pairs	Max (L,R)	L+R-P	MLNI†	%HDR
Humerus	28	24	12	28	40	44,50,79	94.6%
Femur	25	34	19	34	40	40,44,53	94.1%
Tibia	20	22	15	15	27	27,29,35	94.2%
Overall				34		42,45,50	93%

b. Estimations of Recovery probabilities (r) and their standard errors

Element	r	s.e.
Humerus	0.4615	0.0857
Femur	0.6441	0.0726
Tibia	0.7143	0.0790

Table 6.5. MLNI† - The first number in the column represents the lowest value for the highest-density region (HDR), the second number represents the MLNI, and the final number represents the highest value for the HDR. Column to the right gives the HDR% closest to the 95% value.

Table 6.5 reflects the estimated number of individuals from Burial 7. The MLNI calculation is 45 individuals at the Highest Density Region (HDR) of 93%. The HDR is shown in Figure 6.3. The MNI is 34, which is derived from the femur bone. Similar to Burial 1, the tibia has the highest recovery probability at approximately 71%. This is followed by the femur bone at approximately 64% and the humerus, at approximately 46%.

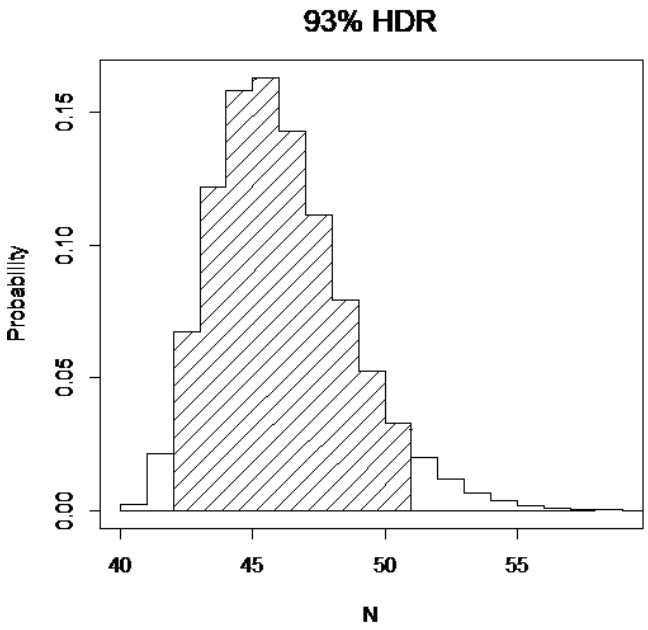

Figure 6.3. Burial 7, Highest Density Region (93%) of all three components.

Burial 7	
chi-square	14.03
DF	2
p	**0.000899**

Table 6.6. Burial 7, chi-square, Degrees of Freedom, and the p-value of MLNI analysis. Significant differences are bolded.

Mirroring the results associated with Burial 5, Burial 7's chi-square Goodness of Fit test has a p-value below the alpha (*a*) level of 0.05. Because this value falls within the significant value threshold, the MLNI technique stands a chance that the Highest Density Region ranges that are too narrow (Adams and Konigsberg, 2004).

Subadult Representation

Although subadult remains were recovered at the Baum site, the majority of the remains were highly fragmented. Given the studies that show that element survival is based on robusticity and overall mass, it is difficult to estimate how many of the elements were destroyed or otherwise removed from the archaeological context through erosion. This is especially so for subadult remains (Willey et al., 1997). In addition, MLNI techniques are specifically built to analyze the most robust elements, or those that are more likely to survive in the archaeological context. Because of the nature of preservation of subadult remains, these elements were not considered in MLNI analysis. Despite this, data gathered during this analysis were kept to show that subadult remains existed in highly fragmented form in Burial 8, Burial 1 and Burial 5. The most common recoverable elements included portions of the unfused cranium, fragmented long bones, and disarticulated epiphyses.

Notes that accompaneid the curatorial contexts of subadult remains offered some insight on the individuation of subadults during excavation. Specifically, some elements identified the following subadults: subadult mandible and maxilla "EEE," subadult cranial fragments "QQ," subadult crania fragments "E," subadult cranial

fragments “TT,” subadult mandibles “B1,” “B2,” “B3,” “B4,” “B5,” subadult cranial fragments “W,” subadult cranial fragments “H,” subadult cranial fragments “S,” subadult cranial fragments “K,” subadult cranial fragments “RR,” subadult cranial fragments “J,” and subadult cranial fragments “BBB.” Although highly fragmented, implications of identification of subadult remains *in situ* give a preliminary understanding of the number of subadults represented. From the standpoint of excavation reconstruction, it also establishes the context required to identify patterning within the burial.

TRANSITION ANALYSIS

Recognizing the value of transition analysis and its utility for fragmented and commingled elements, this method was applied liberally. Thus, all scorable elements were included in anlaysis. The decision to apply transition analysis was based on the attempt to capture the adult age distributions in the most comprehensive manner possible. In order to do this, it was necessary to apply a technique that is flexible enough to consider the realities of an ossuary burial – namely, commingled and fragmented remains. Because associations were often not known between the elements, it is possible that ages estimates were produced independently from one another from different elements.

Transition analysis was conducted on all relevant elements from the Baum Site, including crania and *os coxae*. In total, there are 19 features that inform the estimated age-at-death. Given the fragmented nature of the Baum Site remains. Elements received

only the number of scores that could be made with confidence. Scoring procedures followed closely to the methods employed by Milner and Boldsen (2012). Age-at-death estimations were generated using ADBOU, a software platform developed to calculate estimated age-at-death from scored elements.

Validation studies of transition analysis suggest the introduction of age bias by cranial sutures (Milner and Boldsen, 2012; Jooste et al., 2016; Godde and Hens, 2015; Hagelthorn, 2018). Because of this bias, it was decided that a preliminary analysis would include cranial sutures. Secondary analysis would consider only the *os coxae*, eleminating the cranial scores - even if associations were known between the elements.

Burial 1

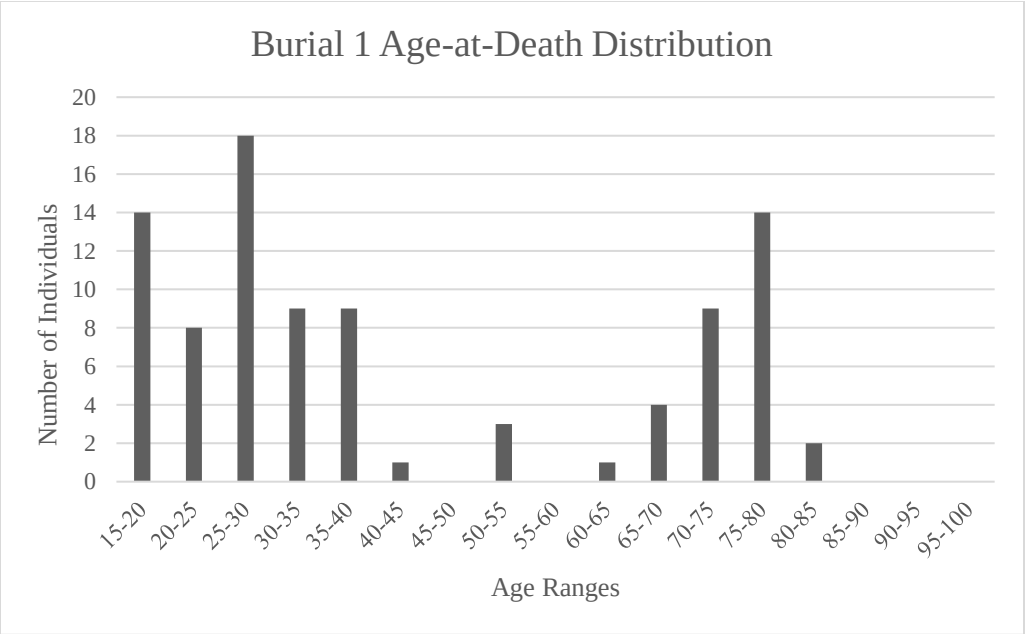

Figure 6.4. Age-at-death distribution based on all scorable elements.

As indicated by Figure 6.4, the data suggests a reduced number of individuals in the estimated age ranges between 40 and 65. Although this drop in representation could indicate the age distribution of the sample, it could also be attributed to the accuracy fall off long associated with estimating the age of individuals between development and rapid degeneration. In addition, consideration for the relative lack of individuals within this age range may be granted to the known biases introduced by the population distribution of the sample from which the technique was developed. Furthermore, employing an "unkown" ancestry model expands the age ranges to include a greater range of skeletal human variability.

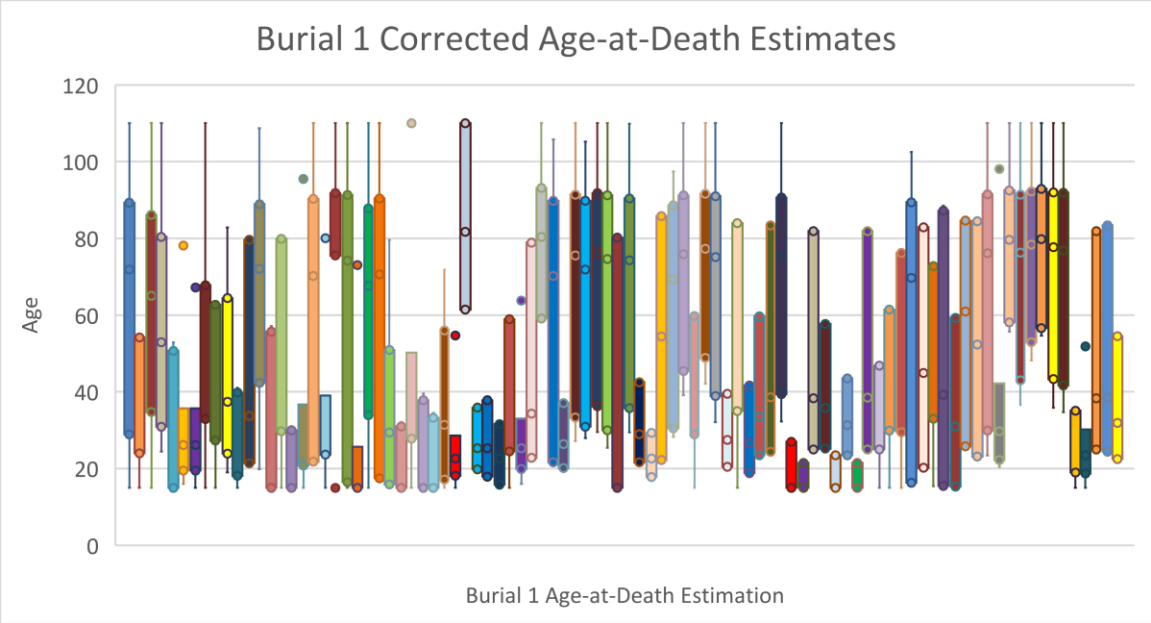

Figure 6.5. Boxplots that depict the corrected point estimate ages of all scorable elements.

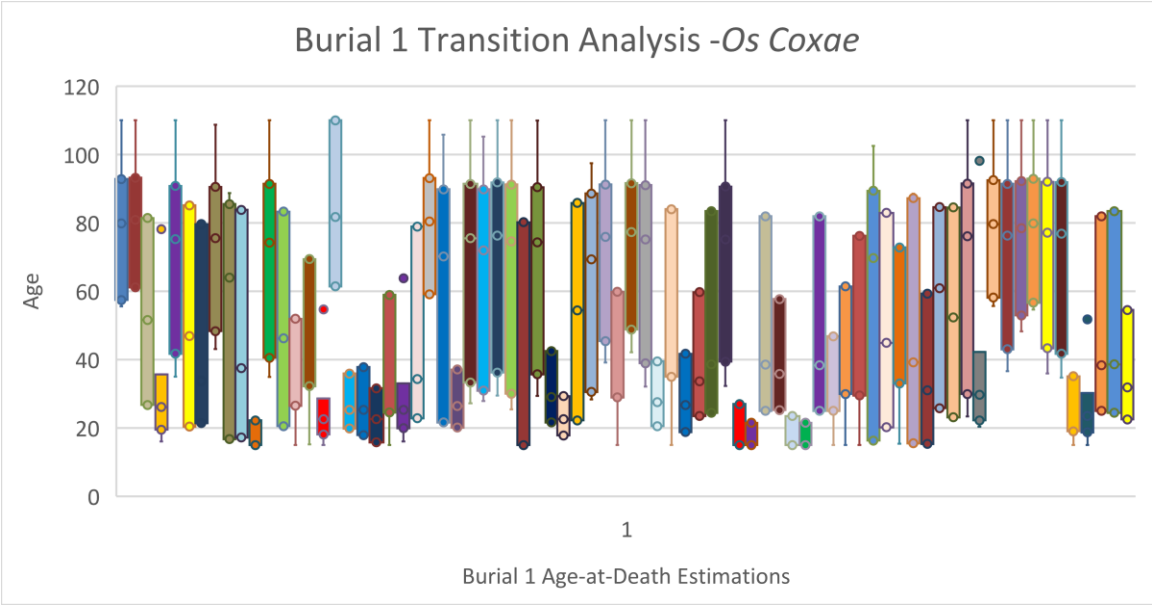

Figure 6.6. Boxplots that depict the corrected point estimate ages of the *os coxae*. Colors follow the pattern of Figure 6.5, for easier comparison.

In an analysis of point estimate age ranges, it is evident that the exclusion of cranial suture scores removes many of the age ranges that vastly under estimate or overestimate the estimated age. The under and over estimation can be depicted by the increased presence of outlier indicators within the box plots, as seen in Figure 6.5 and Figure 6.6.

Feature 1 Ossuary

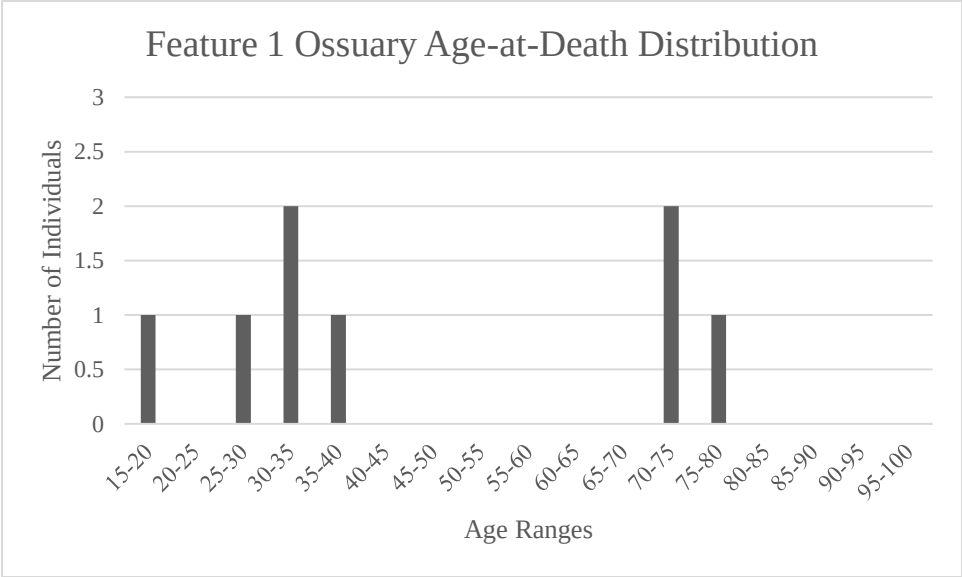

Figure 6.7. Age-at-death distribution based on all scorable elements.

Although a much smaller ossuary than Burial 1, Feature 1 Ossuary encompassed preserved remains that could be scored for an age estimate. Although it is represented by a much smaller number of individuals, as depicted by Figure 6.7, a similar disparity exists between the ages of forty and seventy in this sample as that exemplified by Burial 1.

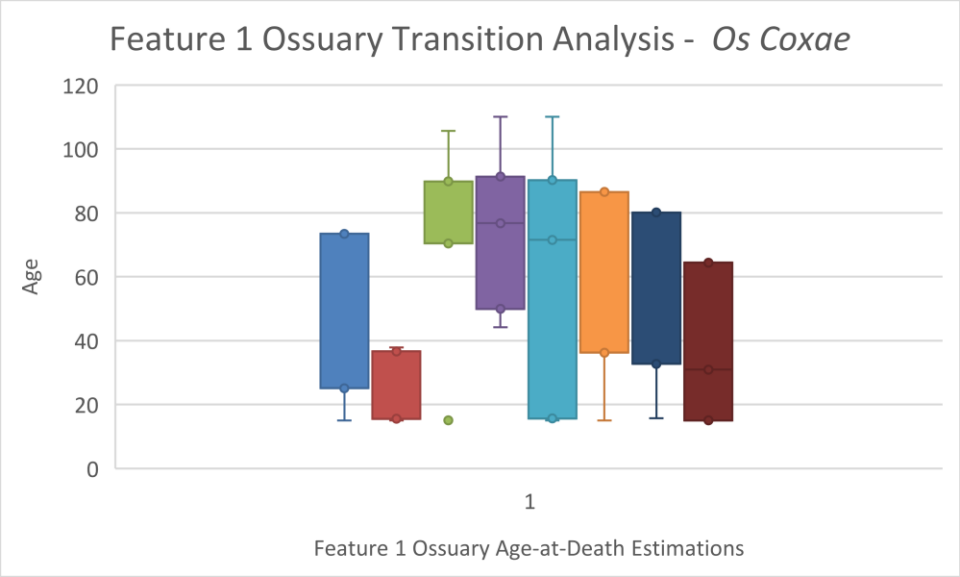

Figure 6.8. Boxplots that depict the corrected point estimate ages of all scorable elements.

Feature 1 Ossuary was entirely based on the analysis of the *os coxae*, as represented by Figure 6.8. There were no cranial elements that were scorable, making this sample's age estimation completely dependent upon the auricular surface. Given the context of Feature 1 Ossuary, which was mostly eroded to the beach and surface, the auricular surface was the most likely element to survive the taphonomic onslaught of coastal erosion.

Burial 5

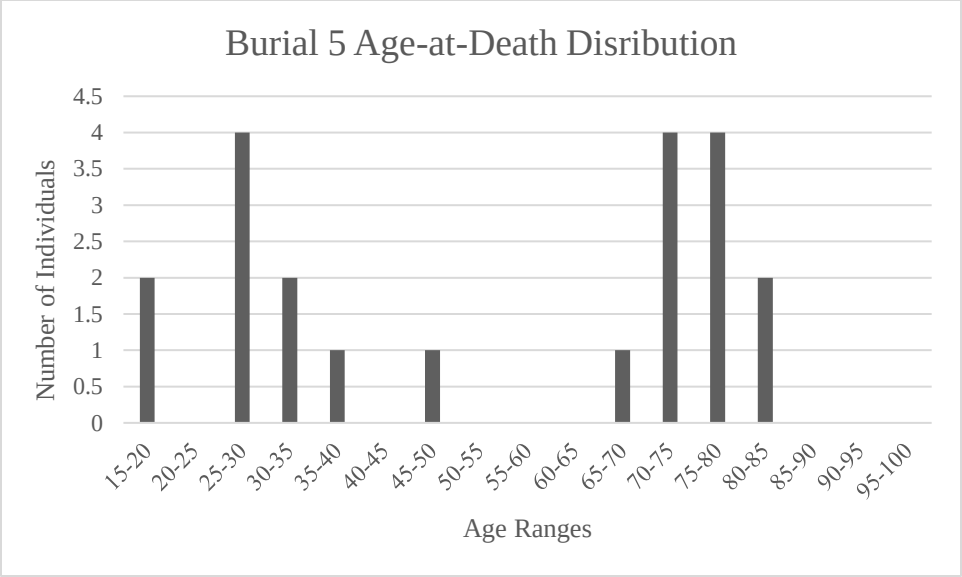

Figure 6.9. Age-at-death distribution based on all scorable elements.

In a manner consistent with nearly the same estimated age-at-death distribution appears in Burial 5 and is seen in Figure 6.9. Other than a single individual's age falling between the 45-50 age range, there is an obvious lack of representation between ages 40 and 65.

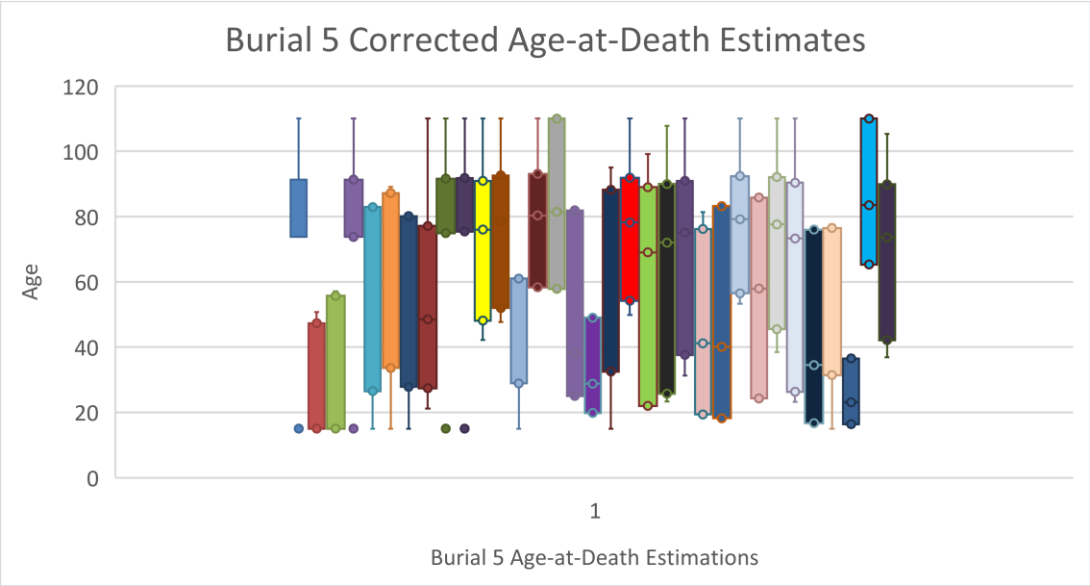

Figure 6.10. Boxplots that depict the corrected point estimate ages of all scorable elements.

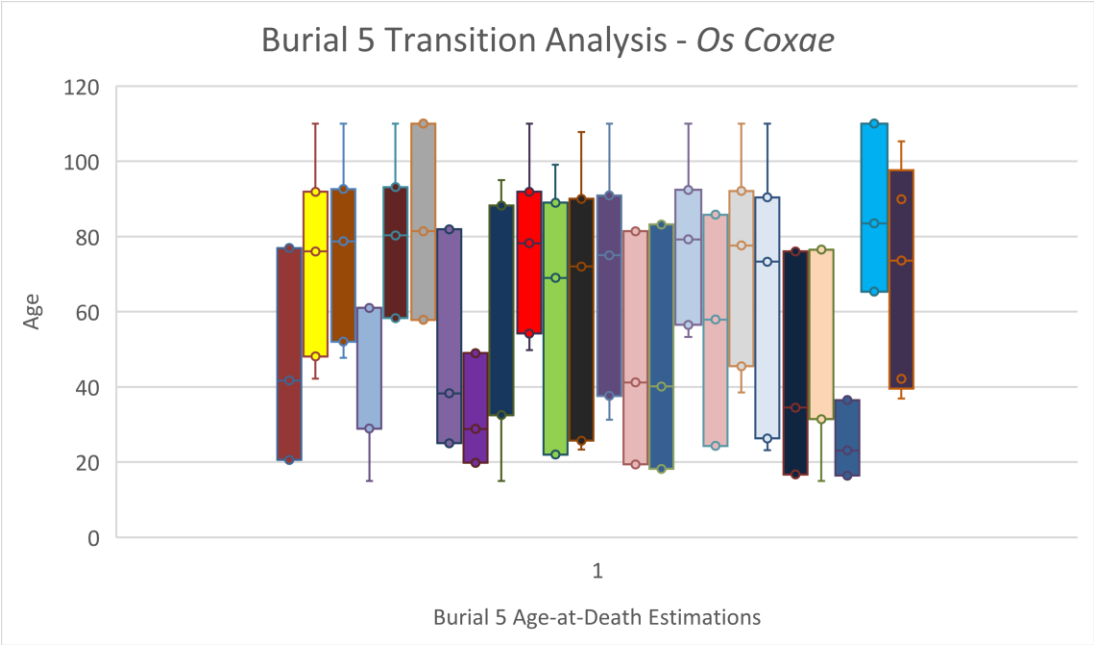

Figure 6.11. Boxplots that depict the corrected point estimate ages of the *os coxae*. Colors follow the pattern of Figure 6.10, for easier comparison.

Figures 6.10 and 6.11 represent the point estimates of estimated age for the *os coxae* and and cranium, and just scores derived from the *os coxae*, respecively. As introduced in Burial 1, depicting the point estimates for scores derived from the *os coxae* show the differences between age estimates between those that include the bias introduced by the cranium.

Burial 7

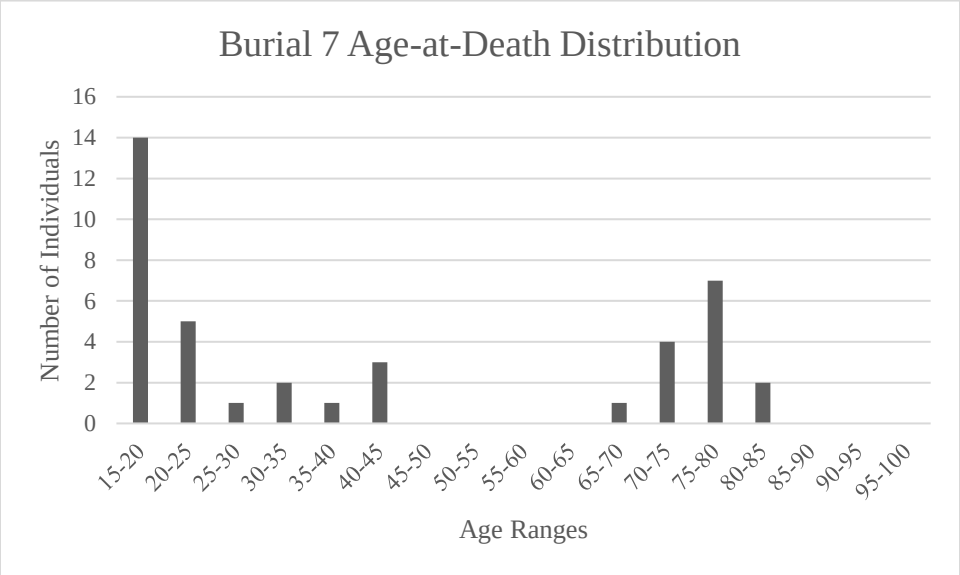

Figure 6.12. Age-at-death distribution based on all scorable elements.

Par for the course in age-at-death estimations, Burial 7 tended to also lack representation between the ages of forty-five and sixty-five. Notable to Burial 7 and reminiscent to the trends of Burial 1, there is an obvious spike in individuals of the estimated age between 15 and 20 as seen in Figure 6.12.

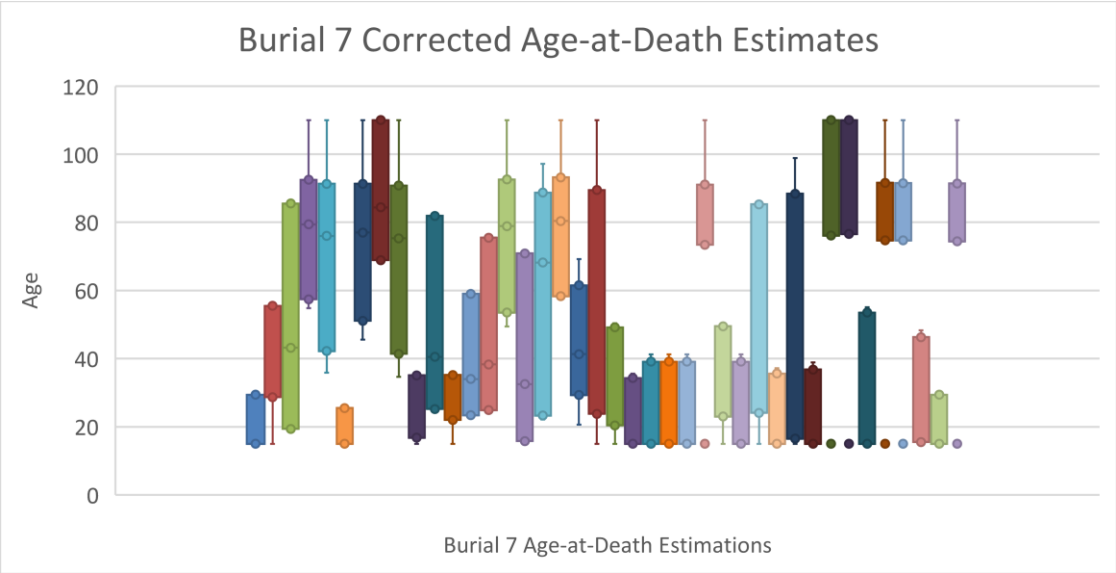

Figure 6.13. Figure that depicts the corrected point estimate ages of all scorable elements from Burial 7.

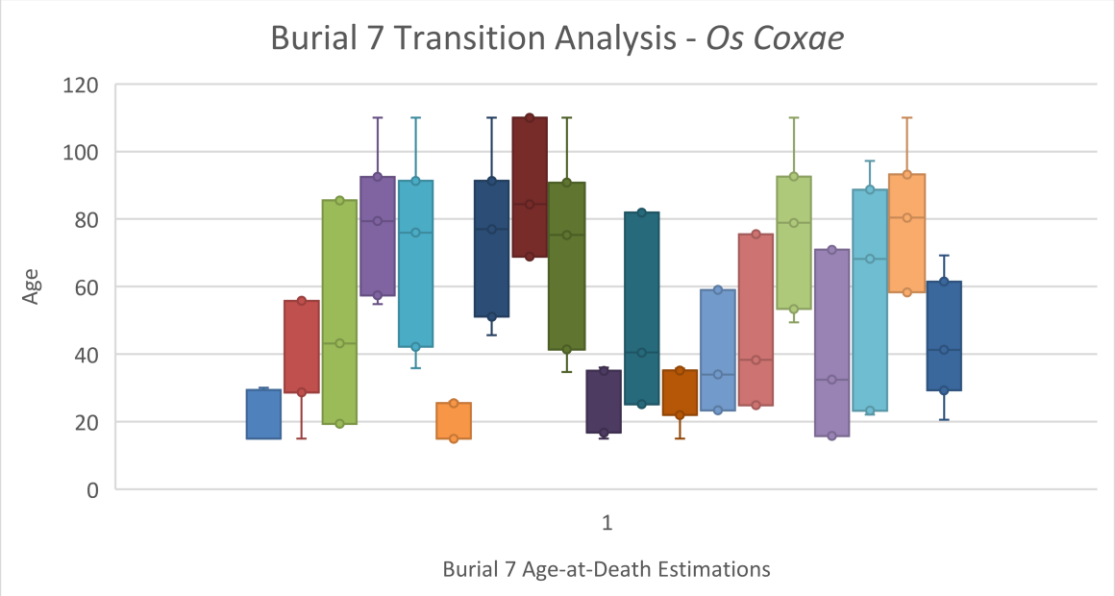

Figure 6.14. Figure that depicts the corrected point estimate ages of the *os coxae* in Burial 7. Colors follow the pattern of Figure 6.13, for easier comparison.

Much as with Burial 1 and Burial 5, estimated age tended to be more refined and within smaller ranges if derived from the *os coxae*. This is represented in the point estimates of estimated age seen in Figure 6.13 and 6.14.

Subadult Age Estimates and Significant ADBOU Results

Given the fragmentary and scattered nature of subadult elements, subadult age estimations were fewer in number. For instance, diagnostic indicators of subadult age such as tooth formation and eruption, diaphyseal length and epiphyseal fusion, and more innovative techniques, such as the formation of the calcaneus were absent or taphonomically diminished to the extent that age estimations were impossible (Sundick, 1977; Passalacqua, 2011; Ubelaker, 1987; Pfau et al., 1994; Hoffman, 1979).

In addition to the age ranges estimated from individuals in the entire ossuary, mention should be made of the estimates that resulted in significant p-values. As an indicator of goodness of fit, these significant results were less than the 0.05 alpha (*a*) threshold and indicate a statistically significant difference between the variables. Most notably, such relationships were seen between the ages estimated from scores of the cranium, and the scores from the *os coxae*. In order to mitigate these statistical differences, it was decided to include the breakdown of age estimates from all scorable elements, and ages estimated from just the *os coxae*. An example of the statistical difference is viewable in Images 6.1 and 6.2.

Burial 1 "I"	L_95%	Point_Est	U_95%	DF	Chi-sq	p
Corrected	38.9	71.9	89.3	-	-	-
Uncorrected	34.9	65.4	101.4	1	7.3	0.01
Cranial Sutures	15.0	19.8	55.6	2	3	0.23
Auricular Area	55.6	93.7	110.0	8	6.5	0.59

Image 6.1 ADBOU generated matrix for Burial 1, individual "I."

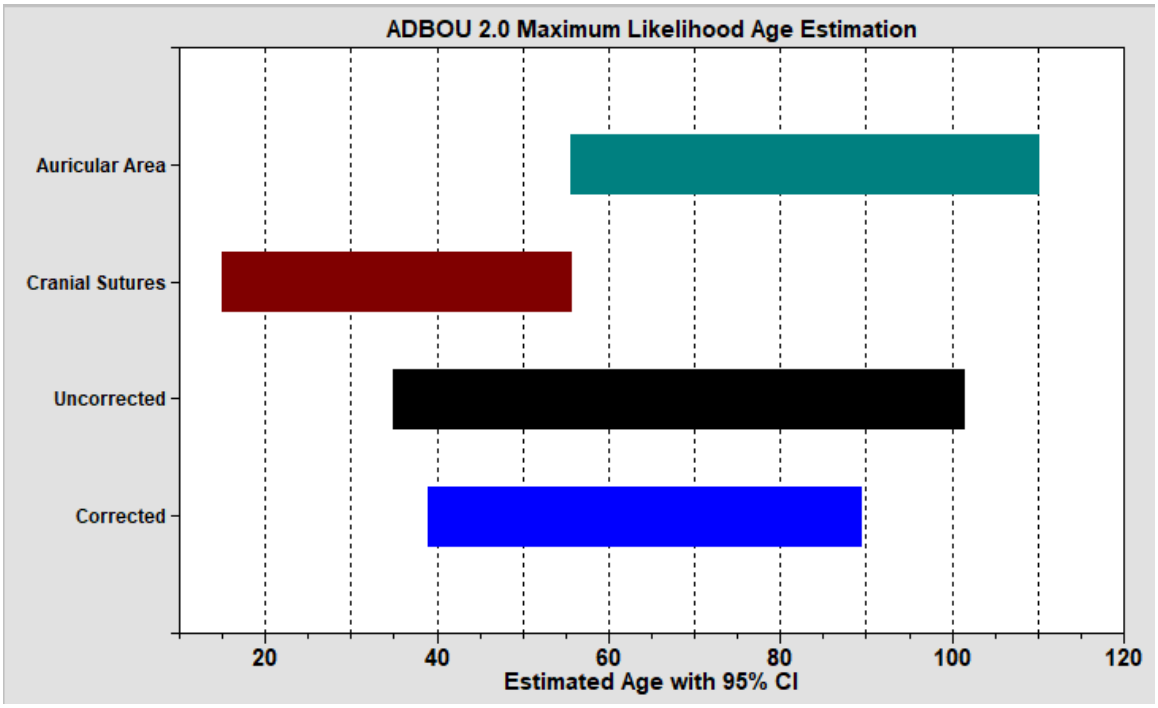

Image 6.2 ADBOU generated graph for Burial 1, individual "I."

CONCLUSION

The data presented in this chapter outline the number of individuals represented within each ossuary and the estimated age-at-death distributions of those interred within the ossuaries at the Baum Site. These values were calculated through the application of

MLNI techniques, and transition analysis. Because there are known biases introduced by using cranial scores, the author sought to mitigate this bias by introducing a breakdown of ages estimated solely from the *os coxae*. In addition, subadult remains at the Baum Site were highly fragmented and even more commingled. Because of this limitation, applications that would impose a level of representation are largely dependent upon curatorial and excavation notes, and notes gathered during analysis of the fragments.

By reconstructing these two facets of paleodemographic focus, the bases for a range of interpretations can be established. This is significant in light of previous approaches that held that commingled and fragmentary remains contained little to no information for bioarchaeological study. Despite this perception, the application of advances techniques that are flexible enough to address individual representation and age-at-death distributions are at the forefront in remedying an otherwise processualist and pessimistic mindset. These data can indeed be the basis for interpretations drawn from applicable interpretative frameworks that continue to expand the understanding of fragmented and commingled remains even further into the biocultural framework at the Baum Site.

CHAPTER SEVEN: DISCUSSION

Bioarchaeology is uniquely positioned to illuminate the complexities of the human experience. While postprocessual archaeology ushered in a careful admixture of empirical evidence and theoretical applications, most archaeological and bioarchaeological thinking tends to revert to processual nihilism when faced with the complexities of a secondary burial. Keeping this in mind, this chapter aims to contextualize the data presented in the previous chapter and lay the foundation upon which further analyses may be developed. Finally, a multi-layer analysis of individual and group identity, agency, and marginalization are addressed. Although this matter cannot be reconciled, visibility is a step in the correct direction for increased mindfulness towards the individuals that make bioarchaeological research not only possible, but meaningful.

BURIAL RECONSTRUCTIONS

Building upon the methodological and theoretical constraints associated with commingled secondary burials and the paleodemographic data established in the previous section, this chapter offers an explanation and interpretation of the data. This includes contextualizing the number of adult individuals, and their estimated age-at-death distribution in a way that sheds light on the creation and symbolic meaning of the burials.

Although the Baum Site predates the period of contact, it is paramount that contextualization drawn from the records that have historically been regarded as unquestioned truth err on the side of caution. From a cautionary perspective, an understanding of the authority dynamic between the indigenous and European explorers informs the interplay between agency and marginalization.

In order to grasp the significance of the Baum Site burials, it is necessary to: (1) outline the spatial arrangement of the burials; (2) consider what relationships the burials have to the landscape, and; (3) integrate the broader archaeological context in which the burials were associated. Much of the archaeological data are derived from Phelps' field report (1980), plan view maps of the site, and Hutchinson's (2002) report on the spatial aspects of the site. In addition to providing information on the landscape of the Baum site, the plan view maps also indicate spatial relationships between the ossuaries and single burials. Furthermore, commingled remains were drawn and individuated by cranium *in situ* with a letter nomenclature.

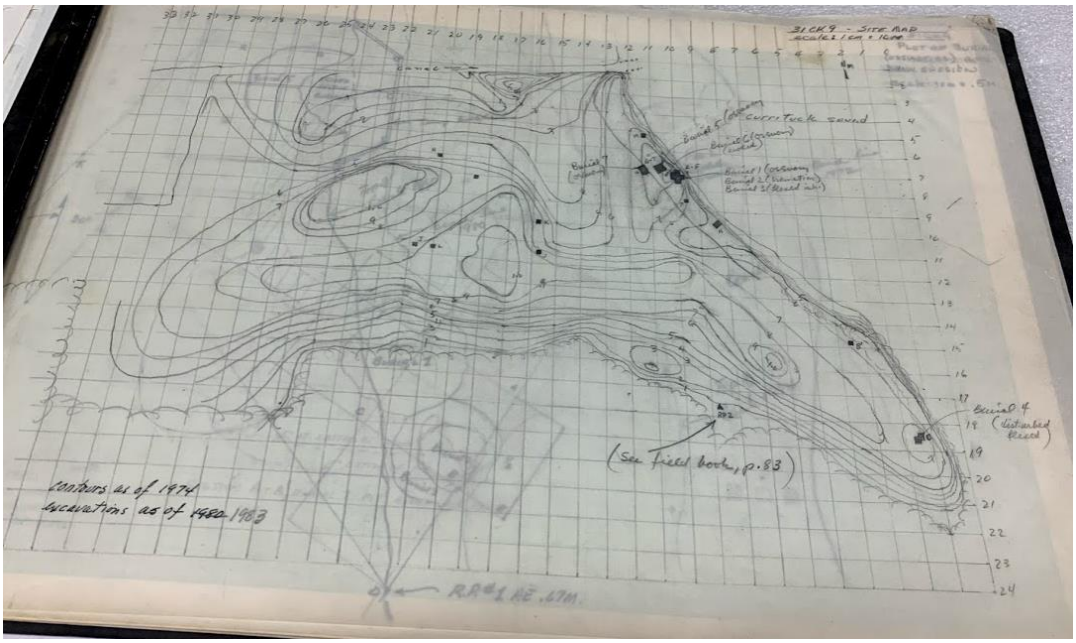

Image 7.1. Plan view and topographic map of the Baum Site. David Phelps's field notes, Department of Anthropology, ECU.

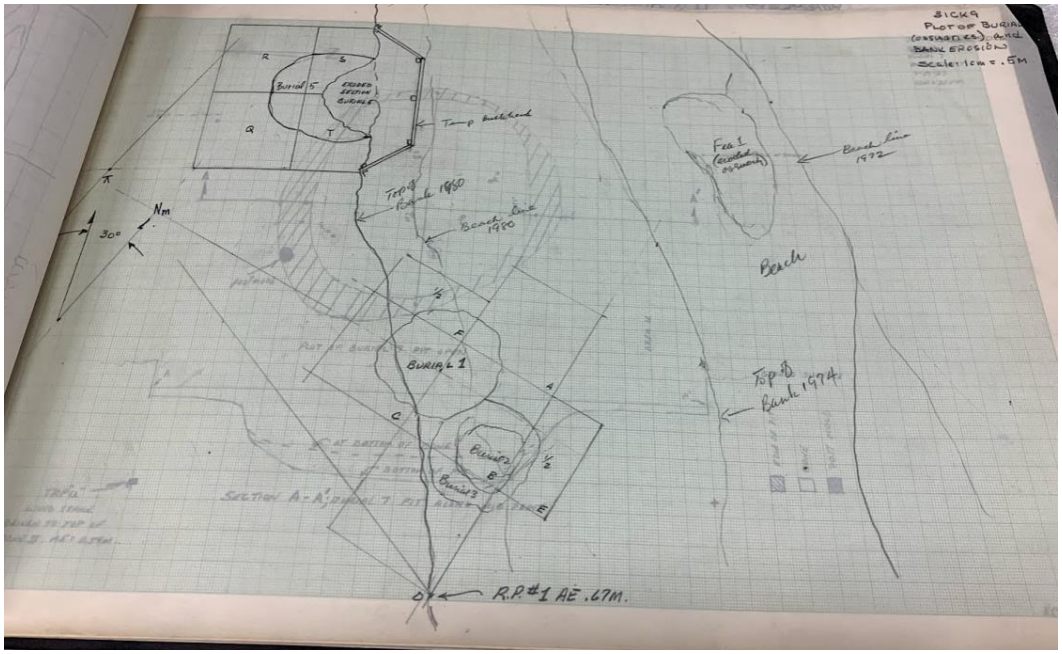

Image 7.2. Plan view map of the clustered burials with shifting shoreline noted. David Phelps's field notes, Department of Anthropology, ECU.

Feature 1 Ossuary

Feature 1 Ossuary was excavated in 1972. By the time it was excavated, the ossuary was so eroded that only the bottom of the pit remained. Despite the catastrophic damage, the bottom of the pit had evidence of both charred and uncharred human remains. Analysis of the elements that remained indicate the inclusion of individuals between the ages of 15 and 40, and those in their 70s. It is likely that the exclusion of individuals between 40 and 70 is based in known biases associated with age-at-death estimation. This being the case, it indicates that this burial was not exclusionary by age.

When discovered and salvaged, Feature 1 Ossuary was bordering the encroaching beach line to the east. By 1974, the beach line had completely surpassed the most westward boundary of the ossuary. This served as one of the earliest instances of known ossuary site loss, due to erosion. The same pattern of erosion impacted all other burials. For instance, by 1980, Burial 1, Burial 2, Burial 3 and Burial 5 would be impacted by the shifting shoreline. Three years later, it impacted Burial 7. In another four years, the shoreline reached Burial 8.

Burial 1

Burial 1 was the first intact burial encountered and excavated in 1973. Composed of disarticulated and bundled remains and eight articulated individuals (Hutchinson, 2002), MLNI analysis suggest an original inhumation of 54 individuals. This falls within

the Highest Density Region of fifty to sixty-one individuals, at a 94.6% confidence interval. The estimated MNI is also within the HDR range, at an estimated 58 individuals (Phelps, 1980). Radiocarbon analysis of human bone date this burial to A.D. 1400 ± 60 years, which was calibrated by Hutchinson (2002) to A.D. 1410. In addition to the individuals within the burial, the panther mask, bone awls, and bone pins were discovered. Burial 1 was located and excavated in the immediate vicinity of Burials 2 and 3 – close enough to even share a group of test units.

Marked in the plan view of the excavation, the panther "muzzle" was discovered under cranium "C," close to the eastern boundaries of the ossuary. Drawn *in situ*, the orientation of individual "C" was not depicted in a way that would immediately suggest that the individual was wearing the muzzle. Interpretation that the muzzle could have been worn is rooted in Phelps's (1980) excavation report for Burial 5, where the remains of the panther are identified as a "mask." Rather, the muzzle was discovered under the posterior side of the cranium. Although the true function and symbolic nature of the panther muzzle is unknown in the context it was discovered, modern ethnographic accounts record Algonkian ceremonies focused on an evil power within the water, the Underwater Panther (Howard, 1960).

Derived from modern ethnographic accounts from the Potawatomi in Kansas, there is a similar origin from the Algonkian language and culture family. Barring the belief that living indigenous can be understood as "living fossils," such lines of evidence, such as long-established oral tradition and ritual practice, can inform loose inferences and belief system contexts (Howard, 1960).

The Underwater Panther, sometimes also known as the Horned Serpent, was believed to be a malevolent spirit. In appearance, the spirit was large, had yellow fur or shiny scales, a panther-like tail, and the horns of a bull. Being predisposed to war, the being was in constant conflict with the Thunderbirds spirits. Furthermore, the panthers were believed to drown individuals, and cover the eyes, mouths, and ears with mud for retrieval (Howard, 1960). The ethnographic description does not describe the use of the panther muzzle in ritual, but this does not preclude the possibly altered practices of the Eastern Algonkian.

The bone awls, known for their function for piercing and carving, were discovered in a much less organized portion of the ossuary – with possible associations to individual "SS," "GG," or "K." In both instances, the inclusion of such items can be interpreted as an attempt to assign identity in a context where individual identity was removed, and instead, reconstructed as a group.

Burial 1 resulted in an age-at-death distribution that appeared to be dominated by individuals 40 and younger, and individuals older than 65. Although Chapter 7 introduced instances of known bias associated with this intermediate age range, it should be noted that subadults are also represented within the plan maps developed during excavation.

Notably, the plan view identifies subadult cranium "QQ" along the western boundary of the ossuary pit. Subadult "TT" was discovered along the southwest quarter of the ossuary burial. Conversely, subadult cranium "K" was marked in the northeastern quadrant of the ossuary burial. Subadult cranium "S" was noted at the northern margin of

the ossuary, while subadult “RR” was in the southeastern quadrant. There is no obvious pattern of burial of the subadults, which incorporates further evidence for the inclusive nature of the ossuary burial – shifting identity away from the individual to that of the larger group.

Burial 2, Burial 3, and Burial 4

Burial 2 and 3, located southeast to Burial 1, were excavated in 1973 and 1974 respectively. Burial 2 was representative of a Middle Woodland primary cremation. A piece of the juncus mat which wrapped the cremated individual was dated to approximately A.D. 360 $\pm$ 65 years. This date was calibrated to A.D. 539 (Hutchinson, 2002). In addition to the remnants of the juncus mat, bone fragments associated with the cranium were associated with a splay of oyster shells. Derived from the excavation maps, there appears to be no oyster shells associated with the postcranial remains. The existence of oyster shells in this context is not surprising – it was the most popular shell found in middens throughout the coastal region (Hutchinson, 2002). The arrangement of the oyster shells around the cranium, however, might be an interesting display of veneration.

By law of superposition, Burial 3 was deposited around the same time or earlier than Burial 2. Burial 3 is represented by a single flexed individual, oriented westward. There is no indication of grave goods associated with this individual.

Burial 4, solely represented by excavation records, was a single subadult, which was highly fragmented and isolated from the other individual burials and ossuaries.

Demarcated during excavation, Burial 4 was located at least 100 meters south of the other identified and excavated burials. It has been interpreted that this was the location of the permanent village, which bordered a forested swamp (Hutchinson, 2002; Phelps, 1980).

Burial 5 and Burial 5A

At the point of excavation in 1980, Phelps estimated that one quarter to one third of the Burial 5 ossuary had been eroded (Hutchinson, 2002). Although some of the elements were recovered from the beach, it is unknown how many or what elements the water rendered unrecoverable. Given the level of disarray caused by the eroded ossuary, a team of archaeologists erected a bulkhead to preserve what remained of the ossuary – namely, three articulated individuals, bundled remains, and other disarticulated remains (Phelps, 1980). In addition to the human remains, archaeologists discovered a pit on the southwestern zone of Burial 5. Based on the size, it was believed that this corresponded to a collapsed post mold.

Despite the obvious impact to element preservation, MLNI analysis estimated the burial to host 43 individuals. This is the intermediate estimate in the 94.8% range, spanning from 33 to 66. The wide range and comparatively low recovery probabilities associated with the humeri, femur bone, and tibiae are reminiscent of the realities of coastal erosion. Field reports written by Phelps (1980) suggest an estimate of 28 individuals within Burial 5.

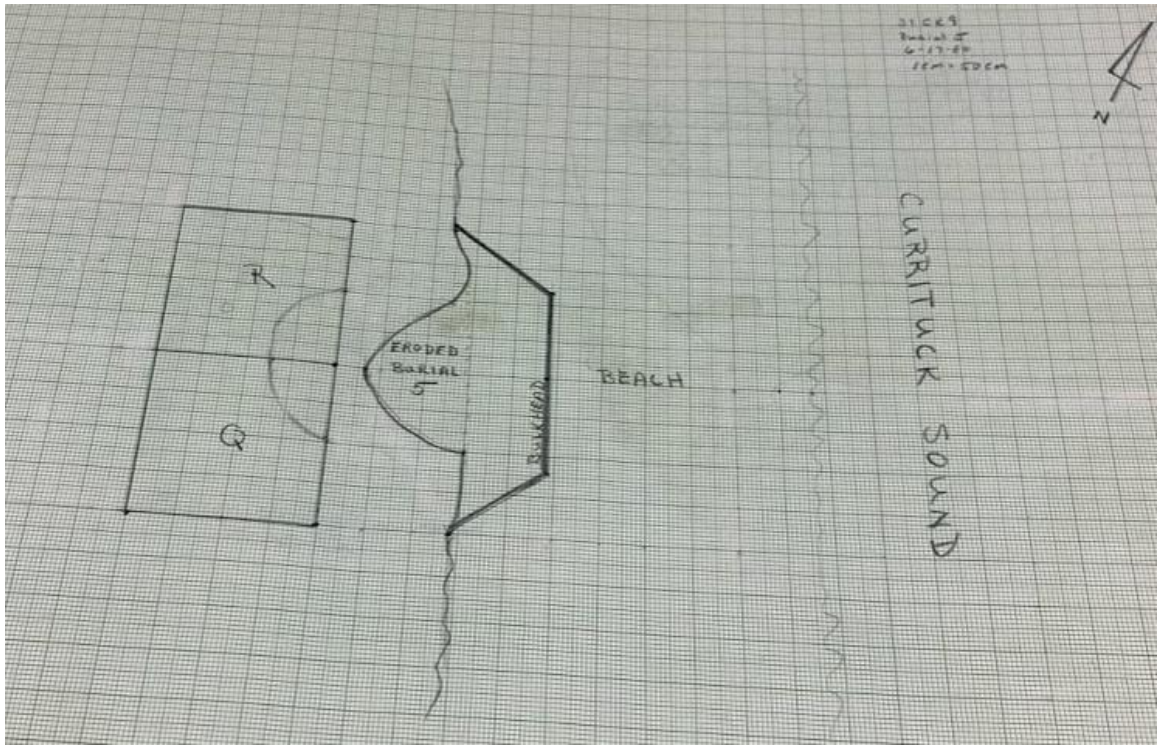

Image 7.3. Drawing of Burial 5 with bulkhead in place. David Phelps's field notes, Department of Anthropology, ECU.

In addition to estimating the number of individuals within the burial, age estimates were also established. Following the trend of Burial 1, there appeared to be a predilection for young individuals and older individuals. In this sample, there were no individuals between the age of 50 and 65. Although the supposed lack of individuals within this age range likely harkens back to the known biases of age estimation, the inclusion of individuals of varying age ranges provides evidence for the creation of ossuaries that are inclusive.

In addition to the human remains, a necklace with fifteen marginella shell (*Prunam apicinum*) beads and a single disk-shaped copper bead was discovered among

the southwest corner of the ossuary, and among subadult remains. Among the few grave goods discovered in the Baum Site burials, the inclusion of the marginella shell and copper bead necklace might have been the last attempt to indicate individual identity (Phelps, 1980). The marginella shells range in size from 9 to 11 millimeters. They were strung by etching a hole in the "shoulder" of the shell, adjacent to tapered spire. The copper bead is approximately 11 millimeters in diameter, and less than 1 millimeter in thickness (Phelps, 1980).

A symbolic status may also extend to the taphonomic alterations to the bone after death. For instance, one preserved cranium was stained red, which has been interpreted as a byproduct of storage in a storage chest. It is believed that the storage of crania, especially intermittently, was reserved for individuals of a higher social status (Hutchinson, 2002). The interpretation of taphonomic alteration is derived from the descriptions and depictions provided by the European, when describing the Algonkian funerary process (White, 1585). Finally, radiocarbon dating of human bone indicated that this burial dated to A.D. 1390 $\pm$ 80 years. When calibrated, the burial is dated to A.D. 1410 (Hutchinson, 2002). Further evidence of cultural use can be derived in the inclusion of sherds that represent the Colington phase. Of the seventy-eight sherds discovered within the burial, seventy-one were associated with the Colington phase. Fifty-eight were fabric pressed, one was simple stamped, and one was plain. Eleven were too small or eroded to determine the finish of the surface. In addition to the Colington phase sherds, a few Mt. Pleasant sherds, including cord marked, fabric impressed, net impressed, and

residual were discovered in backfill. This not unsurprising, considering the site's use in the Middle Woodland (Phelps, 1980).

Burial 5A was located above the Burial 5 ossuary. The body, in a flexed position, was oriented towards the east. The orientation of the cranium, however, was directed skyward. Excavation notes, mapping, and excavation photographs indicate no grave goods associated with the single burial.

Burial 6

Burial 6, believed to have been an ossuary, was almost completely eroded by the time salvage efforts began to gather remains from the beach in 1983. Erosion was believed to be exacerbated by spring storms. A radiocarbon date was produced from one of the few salvaged remains, which incidentally were mostly cranial fragments – specifically fragments of the frontal bone and temporal bone. Burial 6 was dated to A.D. 1310 $\pm$ 10 years, which was calibrated to A.D. 1300 (Hutchinson, 2002). Because of the loss of elements due to erosion and the fragmented state of the remains, no age-at-death estimates or MLNI estimates could be conducted.

Burial 7

Burial 7 was also excavated in 1983, after being exposed by erosion. As with the single red stained cranium from Burial 5, Burial 7 contained four crania with similar stain

patterns (Hutchinson, 2002). If the creation of ossuary burials occurred on a timed interval anywhere between three to 12 years, there exists a pattern of post-mortem processing that only affects certain individuals – possibly indicating ritual activity affecting those that were of a higher social status when alive (Curry, 1987).

Excavation notes indicate a steeply eroded bank encroaching on Burial 7. In addition, excavation plan maps show a discernible post mold along the northwestern outer margin. Because Burial 7 did not experience the same level of erosion as many of the other ossuaries, recovery probabilities ranged from approximately 46% to 71%. The MLNI calculations estimated an initial count of 45 individuals, with a range of 42 to 50 individuals at a 93% Highest Density Region (HDR). Despite the robust recovery, a chi-square Goodness of Fit test indicates that the HDR range may be too narrow, and not an accurate estimate of the number of individuals originally interred.

In addition to the estimation of the number of individuals that compose Burial 7, estimated age-at-death distributions were also produced by transition analysis. In total, 40 elements were scored. The estimated age-at-death produced a distribution that trended heavily towards young individuals between the ages of 15 and 20, followed by older individuals between 75 and 80. There is a complete absence of individuals between the ages of forty-five and sixty-five. Beyond the discussion that introduced the possibility of biasing that trend towards young and old ages, a refined age-estimation was produced from the scores derived from the *os coxae.* This effectively excluded the biases introduced by cranial scores. In addition to the array of adult ages represented, fragmented subadult fragments were also discovered.

Burial 8

Burial 8 was excavated in 1987 and was comprised of at least 3 adult individuals, and one subadult. Although partially eroded, this ossuary included a shell feature in the southeast corner. In addition, the burial had the densest presence of post molds. Of what remained of the burial, there were seven identifiable post molds, one of which was located within the shell features. A crushed skull was also discovered on the boundary of the dense shell feature.

Surrounding the abundance of post molds, archaeologists discovered a crushed *os coxae*, fragmented long bones, some of which were surrounded with a splay of shells, and a bundle of arm bones. Although Burial 8 was highly fragmented and produced no elements that could be used in transition analysis, the burial's unique abundance of post molds coupled with bundled similar elements might indicate the use of this space as a location for mortuary processing, possibly even the location of a charnel house. In addition, this burial had the highest density of non-human skeletal remains of all identified and excavated burials.

The abundance of animal remains might be a byproduct of the further inland location of the burial. The non-human skeletal remains might also be a byproduct of the shelter provided by a charnel house, if the burial is in fact the remnants of the site of mortuary processing. Loss and later recovery of small elements, especially if discovered in concentrated pockets, may be attributed to the collapse of animal burrows. It is for this

reason that Duday suggests that excavation and sifting be employed in burials ten centimeters beneath the location of larger bones (Duday, 2009).

Although now inaccessible due to erosion, careful and tedious excavation of all ossuaries might have resulted in the discovery of a condensed distribution of small elements in a confined area. As outlined by Willey et al., (1997) and Duday (2006), analysis of skeletal elements in context may result in a better understanding of spatial use. In the case of Burial 8, the loss of small elements may provide evidence for mortuary processing of many individuals in one location. An example of such occurrence is identified by Duday (2009), in which analogous small bones from the "*pourrissior,"* or processing house, matched what was missing in the secondary burial. These included the carpal and tarsal bones, phalanges, portions of fragmented long bones, unfused epiphyses of subadults, and isolated teeth (Duday, 2009). In a similar fashion, the presence of these smaller elements could be compared to the presence of larger bones, such as the femur bone, to gauge representativeness.

CONTEXTUAL BIOARCHAEOLOGICAL CONSIDERATIONS OF COMMINGLED REMAINS

A series of themes emerge in the literature surrounding the bioarchaeology of commingled and disarticulated remains (Osterholtz et al., 2014). Having effectively made the point that every ossuary is different and must be considered in a way that the

researcher deems fit, the work acknowledges the importance of the relationship between data maintenance and theoretical applications.

Typically, these connections stalemate with the inextricably difficult nature of excavation and post-excavation data collection from disarticulated remains (Osterholtz et al., 2014). Efforts that attempt to bring the data into a biocultural framework do so in various ways, some of which are developed based upon the archaeological contexts of the site. By introducing the methodological and theoretical realities of secondary burial, it is helpful to define three types of secondary burials, the ways in which they are formed, and the characteristics that help identify them.

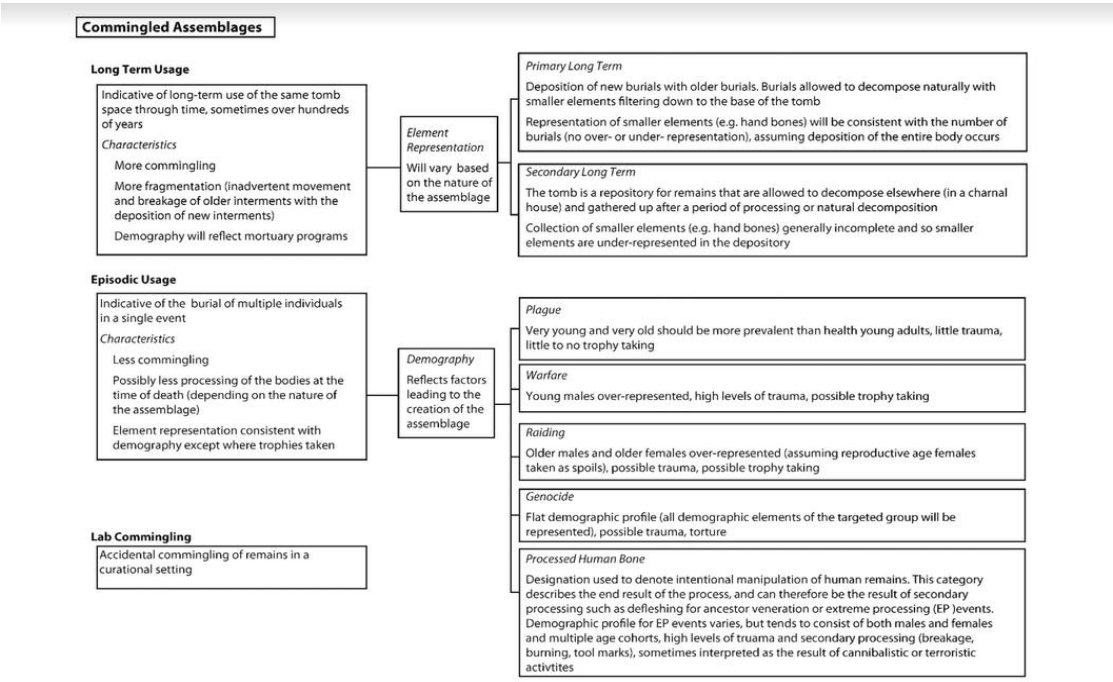

Figure 7.1. The creation of commingled assemblages, developed by Osterholtz, Martin, and Baustian (2014)

As outlined in Figure 7.1, there are three primary kinds of commingled assemblages. These include Long Term Usage, Episodic Usage, and Lab Commingling. The Baum site, in nature of the burials themselves and the contexts that identify the use of the charnel house as a form of mortuary processing, can be placed into the Long Term Usage category, specific to the Secondary Long Term branch. Processing in a separate location, excluding the remains that appeared to be primary, result in the remains having been bundled and deposited randomly (Osterholtz, 2014; Phelps, 1980; Hutchinson, 2002).

Although cultural practices place the Baum site in the orbit of the Long-Term Usage framework, the Episodic Usage framework specifically mentions the inclusion of the very young and the very old. Because the Baum site hosted individuals ranging in age, the ascription to a framework based on cultural mortuary practices cannot preclude the demographic composition of the burial (Osterholtz et al., 2014). Of course, lab commingling can never be ruled out, as such would be hard to track from the initial creation of the curatorial contexts (Osterholtz et al., 2014).

The range of estimated ages can possibly be attributed to the intermittent creation of Algonkian ossuaries, and significant time in between depositional episodes. This would have allowed for the incorporation of the very young, the very old, and ages in between from communal contexts over a span of time ranging from an estimated three to twelve years (Curry, 1987; Biggar, 1929; Brebeuf in Thwaites, 1897). Even if the ossuaries were created with significant time in between events, the area has been interpreted as a cemetery area based on the evidence of spatial use in respect to the sound

and village, the use of the land from both Middle and Late Woodland contexts, and the absence of intrusive burials or cuts (Curry, 1987; Phelps, 1980).

Postprocessual Interpretations of the Baum Site

In addition to the framework that considers the creation and symbolic function of a burial, the Baum site has had tangential interpretations as a form of village burial site. Belonging to the Colington phase, communal burials of 60 individuals or fewer (with bundled individuals possibly representing individual family units) occur on sandy ridges on the cusp of land and water. Believed to have bordered the village, these locations are only slightly removed from typical habitation sites (Curry, 1987; Phelps, 1980; Phelps, 1982; Loftfield, 1990).

"Cemetery areas'" are one of three distinct burial locations that also include those occurring within the village, and those that are in isolated locations. Interpretations of the Baum site fall somewhere in the mix of the cemetery area and the village burial, given the location and the creation of ossuaries within a certain distance and positioning of one another (Curry, 1987).

Postprocessual conceptualizations of place and space in mortuary behavior add significance and symbolic meaning. The placement of the deceased within a physical location that can be separated as sacred creates an "eschatological" map that can inform the actions and relationships between the living, the deceased, and the supernatural. (Parker Pearson, 1993). The transformation of the living and the dead in a certain place

and space, represent social agency and living-dead interactions (Silverman, 2008). These living dead interactions also depend on the landscape, which are symbolically constructed by social, political, and economic contexts (Halprin, 1995; Silverman, 2008).

Transformations from living to dead depend on social space, or the position the person occupied. Social space is lived, practiced, and negotiated (Silverman, 2008; Bourdieu, 1990; de Certeau, 1984; Lefebvre, 1991). Place, on the other hand, is the temporal and physical setting for activity. Individuals can place symbolic capital upon places, and this place then dictates action and expected outcomes (Silverman, 2008; Jakle, 1987). Space and place are interdependent, meaning that "human action takes place (happens, occurs) in place (location, space) and thus takes place (creates place, creates space)" (Silverman, 2008, pg. 3; Smith, 1987). In essence, place instructs behavior and practiced behavior, as space, reinforces place.

The internal appearance of the remains also has significant impact on the interpretation of the ossuary. For instance, Phelps (1980) notes that at one of the Baum ossuaries, 30 individuals were placed on the bottom layer of the ossuary. Of the thirty, three were articulated and a few appeared to be bundled. The rest were completely disarticulated, with some elements arranged vertically or leaned against the wall of the ossuary (Curry, 1987). Although this is a brief glimpse of the necessary measures to understand a site through *in situ* contexts, a more comprehensive understanding of the utility of archaeothanatological methods are considered in a later section.

The realities of ossuary creation and use at the Baum site are important to note, considering the existence of a few primary burials. For instance, Ossuary 5 had three

articulated skeletons within the main part of the ossuary. While in the process of backfilling above the ossuary, a single articulated individual (Burial 5A) was placed within the burial. Because there was no evidence of a secondary, intrusive cut, a few interpretations for this contextually “deviant” burial have been offered. For example, it has been suggested that perhaps a family arrived late with a recent decedent, who would not have been dead long enough to warrant processing within a charnel house. Another interpretation is that an individual died during the ceremony, and was included without mortuary processing (Curry, 1987; Phelps, 1980). Another interpretation, although loosely constructed, postulates that the individual was of a different status. The literal placement of a more corporally-whole individual and in a higher stratigraphic category, may be symbolic for the status of the individual. Given the small number of grave goods overall, the exclusion of symbols of high power for this individual may not be surprising (Curry, 1987).

Aside from the possible symbolic meaning of the individual placed in a stratigraphically elevated position, the inclusion of a panther mask at the Baum site has been interpreted as a component of ritual practices, possibly related to shamanism (Phelps, 1980). In addition to the panther mask, Hutchinson also notes the existence of red staining on five crania. This is possibly linked to the storage of the crania in reed boxes that were stained red, demarcating the identity of the individual as possibly a chief. Contexts that provide support for the use of the box is derived from a watercolor produced by John White, when visiting the Secotan (Hutchinson, 2002; Phelps, 1984; White; 1585).

Although not common or widely dispersed within the contexts of the Baum site, there exists at least one instance of bead inclusion within the ossuary. Having had known associations with deceased and buried children in other regional ossuaries that also ascribed to the Algonkian archetype, such as the Hollowell Ossuary, tangential evidence for the intimate display of the identity to a child can be made (Curry, 1987; Curry, 1999). In addition, the inclusion of bone awls may refer to the identity of an individual, as this is a utilitarian piercing tool (Phelps, 1980).

On a broader scale, some consideration of the status of the group within the ossuary, in its entirety, has been considered. The relative lack of goods to denote identity and status may be removed from the overarching status of the group. For instance, Potter (1993) considered the possibility that individuals outranking commoners, but not quite to the point of warranting separate and elaborate chiefly burials, might have geographically isolated ossuaries. Such burials are possible, although there are no grounds for the Baum site to ascribe to this particular status exclusion.

Instead, a heuristic understanding (and not one intending to make any direct connections to the Baum site via analogy) of socioeconomic-necessitated communality can be drawn from the creation of the secondary burials from Madagascar. Secondary burials, having little in way of mortuary goods, can be loosely be interpreted through an ethnohistoric analysis of Madagascar's population distribution, socioeconomic status of people within certain locations, and indicators from skeletal remains that indicate differential access to resources. In this sense, communality by secondary burial in highland Madagascar has received much attention for the variation in secondary burial

funerary program when compared to the more elaborate and hand crafted tombs that are created by the individual that would one day be interred within, and the rituals that accompany caring for ancestor remains. Although undoubtably impacted by contact, secondary burials, known as "Famadihana," in the highlands have been described as "humble" places of burial for the impoverished that reside in locations with high population density. In other instances, pits were reserved for village moieties, and represented an extension of mortuary variability (Jeffreys, 1827; Tyerman and Bennet, 1831; Vogel, 1982; Larson, 2001). The existence of these secondary burials, as representative of communality by land use necessity, socioeconomic status, or as a voluntary group, is in direct contrast to the funerary programs in other parts of Madagascar.

Although a lack of grave goods has previously been interpreted as corresponding to those of a lower socioeconomic status, the incorporation of belief systems offers other lines of contextualization. Almost parallel to the function of the secondary burials, ideations of the afterlife possibly became less about the individual and more about the burial custom (Ucko, 1969; Childe, 1945). In addition, the superimposition of socioeconomic status based upon the dearth of grave goods is unfounded. Historical interpretations of this nature assume that the logistics that go into large or elaborate burials must have been made for rulers, chiefs or kings of some sort (Ucko, 1969; Childe, 1958; Fox, 1959; Griffiths, 1960). A baseline understanding of communality can be derived from the attempt to physically represent a sense of "belonging" for the group through the form of a communal burial – much like the tombs that are constructed over

the life-course in Madagascar. There is a motivation of creation for a space for long-term existence (Ucko, 1969).

The debate regarding the social status and use of secondary burials also exists for the Algonkian culture. Specifically, debates surround the dearth of reliable ethnographic materials that inform differences in mortuary practice when social inequalities are known. Ethnographic accounts from Virginian Algonkian settlements indicate that higher status individuals had an afterlife, and that commoners did not (Gold, 2004; Rountree, 1989; Rountree, 1990). As a symbolic representation of this, the individuals within a higher social status might have been permanently or temporarily interred in an above ground location, such as a charnel house (Gold, 2004; Rountree, 1989; Rountree, 1990). If this were the case, it is likely that the ossuary contexts are solely composed of commoners (Rountree and Davidson, 1997). In the case of the Baum Site, cranial staining may provide evidence for some time spent in a specialized storage unit. If this is the case, these individuals eventually were interred with the rest of the group. It cannot, however, be assumed that taphonomic processes reduced the visibility of staining on other remains. In addition, Curry (1999) suggests that differential disarticulation of individuals may symbolize the difference in socioeconomic status in life.

Although Speck (1924) did not analyze the remains of the North Carolina Algonkian, or even indicate knowing of the existence of the Baum site specifically, an impressive history and interpretation of Algonkian migration is established through historical documents, linking linguistic families, and tracing cultural features. Acting upon such an interpretation allowed Speck to suggest that southern migration occurred

possibly under war-like circumstances or environmental constraints, and the establishment of new areas of habitation (Speck, 1924). In addition, a brief mention of customs includes “ceremonial and religious rites of special significance are the burial customs, bone burial, cleaning the bone of important persons, the mortuary house or temple, and the like” (Speck, 1924, pg. 193). This interpretation is based upon the overt linguistic similarities, despite some evidence for divergent regional dialects. In addition to demarcating linguistic families, Speck described the names of each sub-group and roughly outlines known areas of habitation – pulling heavily from texts written by explorers such as those provided by John White.

Although Loftfield (1990) does not describe the Baum site specifically, the ossuary at Camp Lejeune is in the same geographic region and likely corresponds to related Algonkian settlements that displays similar ossuary styles. Based upon the excavation and subsequent lab analyses of burial demography, the first type of ossuary burial found at Camp Lejeune contained fewer individuals and is likely associated with a family unit. These burial types are typically located within the boundaries of the village. The second type of ossuary style discovered are typically located outside of the village and are comprised of many individuals. Although a greater number of individuals are buried in this manner, fragmentation and commingling is a byproduct of this type of funerary activity. In some instances, an individual may be represented by a single element. The mixture of two burial programs is associated with Algonkian and Siouan acculturation. In addition, these burials have been known to contain phalanges attributable to *Felis*, or a feline. Building upon the mixture of cultures, as a general

interpretation of similarities in burial practice that informs population interaction (such as that known to have occurred at the Baum Site), Loftfield describes incidences of primary cremation at the Camp Lejeune site which are “notably different from the northern patterns of Iroquoian or Algonquian ossuary internment” (Loftfield, 1990, pg. 118).

A Cautionary Tale of Theoretical Applications

Considering the frameworks that aim to understand biological stress and the punctuated research that has incorporated elements of the Baum site to draw comparisons from, it is necessary to understand why paleopathological reconstructions of secondary burials can be applied generally, rather than specific to a single individual. In short, individuation cannot always be established with a level of certainty. In cases of known associations, paleopathological analysis can delve into a much more intuitive form – one that draws ties between early biological stress and later manifestations that are persistent or severe. Of the eight ossuary burials, there are only a handful of individuals with recorded associations. Spanning the Middle and Late Woodland, these include the single individual from Burial 2, Burial 1 "Y,” Burial 1 “O,” Burial 7 “Y,” Burial 7 “K,” Burial 3, Burial 1 “UF,” Burial 1 “U,” Burial 5 “C,” Burial 5 “D,” Burial 5 “A,” Burial 5 “UII,” Burial 1 “UBB,” and Burial 1 “UHH.”

As data collection progressed, it became apparent that the curatorial packaging was not dependable as a true indicator of element association. This was initially discovered when one unit, supposedly representing a single individual, contained two

femora of vastly different sizes. In addition, the two femora were sided as belonging to the right side of the body. In another instance, elements of Burial 3 were found packaged with Burial 7. In some instances, the elements were pencil marked with identifying markers which provided further evidence for the association. Primary evidence to confirm supposed associations were the same analyses used to pair match the disarticulated and commingled remains.

Given the initial curatorial mixing and subsequent attempt to rectify the location of the remains, the inability to assess the recorded indicators of individuation and analysis that focuses on indicators of biological stress are fraught. The presence of individual stress indicators may appear to provide a glimpse at the lived environment, but this is a far stretch to reconstruct the greater lived environment of the group on these bases. Furthermore, discerning the connection between early life stress and later manifestations that attributed to the death of a single individual are difficult, if not impossible, when the complete picture (i.e., the maximum amount of skeletal data for an individual) is not known with certainty. Despite this limitation, which is a shared constraint for many ossuaries that do not have preliminary insights to individuation, paleopathological analysis can be applied at a general level.

Many of the pathological data ascertained from individual elements have been represented in previous work. This includes the instances of cranial lesions and abnormal diaphyseal thickening of the tibiae that indicate endemic treponematosis. In addition, nonspecific periosteal reactions were commonly observed on long bones. Understanding

that nonspecific periosteal reactions cannot be linked to a single underlying condition, observation is limited to acknowledging its presence.

Analysis of articulated and disarticulated dentition offered insights to significant wear of the enamel. Oral health ranged from dental arcades with very few dental caries, to individuals that were almost entirely edentulous. When maxillae and mandibles were better preserved, active infection of the alveolar margin resulted in significant pitting and bone loss. In addition to general discussion of oral health, existing dentition have the capacity to offer age-at-death estimation and insight to life history models through cementum annulation, and discernible disruptions (Kagerer and Grupe, 2001; Radovic, 2012). In addition, isotope analysis of the dentition can illuminate diet, while analysis of calculus may hold information regarding the oral microbiome around the time of death (Turner et al., 2014; Velsko and Warinner, 2017).

THE INFLUENCE OF EUROPEAN HISTORIES

Beyond the more commonly recognized impacts of European contact on the health and wellbeing of Native Americans, contact resulted in a “story house” or mythos of primarily Western-based histories that are still in circulation today. Although not all of these are outright critiques of the perceived culture of the Algonkian, the histories are written primarily as observations gathered through brief and imaginably, linguistically fragmented interactions that were further quite culturally uniformed. Given this, ethnohistories that objectively provide information on cultural practices, religion, and

many other facets of life do not exist – especially when the purpose of gathering such types of data were motivated to illuminate intricacies of the culture that could be used to advantage Europeans during colonization. This makes bioarchaeological perspectives all the more valuable.

Observations of the Algonkian are laden with the cultural biases of Western perceived norms and ideas. Although dated to after the creation of the Baum Site, these connotations of backwardness, "savagery" and simplistic livelihoods are perpetuated using images and travel diaries that have circulated into modern-day history books. Although not outright prohibited, a level of wariness and skepticism should accompany the use of histories that are written from the perspective of the colonizer. Instead, responsible historical inquiry should recognize that what is made available to the public was recorded and written by a Westerner, for a Western audience, focused on particular "interesting" aspects of a culture that is complex and multifaceted, and similarly censored for reasons that are lost to time. Such is the case of the Monacans of central Virginia. Although European explorers did not make contact until the seventeenth century, the knowledge of these peoples were based on the histories of the geographically more expansive Powhatans, and the "ignorance" of the English (Gold, 2004).

Original inhabitation, European contact, discovery and excavation of the Baum Site, and interpretations and proliferations of European histories are introduced in previous chapters. Building upon this foundation, an analysis of identity, agency, and marginalization is introduced. This framework sheds light on the dynamic and interwoven factors of identity, the relationships identity has with agency, and the

marginalization of certain groups through the unequal distribution of power. Significance of this discussion is rooted in the identification of these upheld structures on a site and group of individuals who are already marginalized in bioarchaeological inquiry by the nature of their burial. Although far from a complete analysis of structures that impose decisions on behalf of the individuals from the Baum Site, discussion has the potential to result in a more mindful bioarchaeology. It allows the opportunity for bioarchaeologists to develop more reflexive interpretations regarding the relationships established between the researcher and the researched.

Identity, Agency, and Marginalization in Secondary Burials at the Baum Site

In addition to the inaccurate representation that occurred at the hands of European published and circulated media, there is a lack of historical representation of the individuals who were interred on the bank of the Currituck Sound. As discussed earlier, the land that the remains were found on had been in the Baum family for generations. Cognizant of the ethical ramifications of disturbed human remains, the Baum family alerted officials. Correct in reporting the burials, this section addresses the identity and agency of the deceased, the dearth of resources and empowered representation that exist at a state level, and the marginalization that emerges as a byproduct.

North Carolina has eight federally recognized tribes, none of whom today affiliate with Algonkian culture or language. The tribes include the Coharie, the Eastern Band of the Cherokee Nation, the Haliwa-Saponi Tribe, the Lumbee Tribe, the Meherrin Indian

Tribe, the Occaneechi Band of the Saponi Nation, the Sappony, and the Waccamaw Siouan Tribe (North Carolina Department of Administration, 2020). Without legally mandated representation, identity tends to rely on historical simplifications.

Loss of identity is not new to the individuals who were once interred in present day Currituck County. Cultural practices of secondary burials remove individual identity and transform the group into one that is bound by the most immediate and striking commonality – a group identity that relies on the loss of personal identity. In response, there is a social shift of the living that accompanies the transition from life to death, in whatever form of preparation that occurs (Hertz, 1907).

Human remains and the manner of disposal incorporate material symbols that can transcend loose interpretations of status and inform identity (Shanks and Tilley, 1982; Mauss, 1973). In this way, an individual's most natural and powerful instrument of identity is his/her/their/ bodies. At a broader level, the culture may employ the body as a construction of reality. Even as an agent of symbol within the cultural milieu, "any change in the definition of the body is incapable of severing physically or symbolically the integral association of different parts of the body or the skeleton" (Shanks and Tilley, 1982, pg. 135; also Mauss, 1973). The elements "form an integral part of an irreducible whole," even when physically separated into symbolic analogous systems (limbs, head, neck, trunk, hands, and feet) (Shanks and Tilley, 1982, pg. 135; Mauss, 1973). Reminiscent of the contextualization provided by Shanks and Tilley (1982), the identity of the individual body, although the tool to represent identity, operates in death as a symbolic structure that society may operationalize, such as through the belief dictated

orientation of the body (Perry, 1914). From this context, ossuary burials assert the new identity of the collection over the individual identity of the living through a pattern of disarticulation – through a pattern of arranging remains that is not meant to intentionally reduce the individual, although representativeness of skeletal remains has certainly been impacted by taphonomy and coastal erosion, but establish a new identity.

In an associated manner, agency can be understood by virtue of relationships, which can either be between people or people and objects (Gell, 1998; Robb, 2010; Robb, 2013). Identity can shape agency and, in many cases, operationalize marginalization through instances of structural violence (Klaus, 2012). Marginalization extends to the identification of individuals who are outside of the normative and are typically relegated to an identity of "other." As with identity and agency, marginalization is contextually dependent upon the social environment in which the normative scenario is constructed and perpetuated. What is considered normative may change over time.

Identity, Agency, and Marginalization of the Individuals at the Baum Site

The individuals interred at the Baum Site have received a series of identity shifts that have associated manifestations of agency and varying level of marginalization. The stages of identity, agency, and marginalization addressed here traverse the stage of burial processing and extend to the current contexts in which the individuals ascribe.

At the point of deposition into the ossuary, identity was effectively transformed from the locus of the individual to the communal. Processing in the charnel houses, to

remove the soft tissues that dictate personal identity and appearances shifted the individual into a group with a common theme – one without obvious or recognizable individual identity. Because there has been some debate on the possibility of extended time between pre-depositional processing and placement in the ossuary, it is possible that some identity remained – especially for those individuals who appear to have red staining on the cranium, possibly indicating the preservation of individuals of higher social status (Hutchinson, 2002; Curry, 1987). This manifestation of social status possibly indicates social inequality during life, even if it is fictitiously represented in the final deposition. In either circumstance, whether it be an extended processing period, a relatively quick deposition, or preservation of a certain element, a relationship between the living and the deceased existed as a form of recognized social identity and agency (Hertz, 1907; Robb, 2013).

In life, social agency may be mobilized by rituals associated in a rite of passage. The use of the charnel house, spanning from the removal of soft tissue and the final disposition within the ossuary can also be equated to, in some fashions, a liminal space (Van Gennep, 1909). The preceding stage, known as separation, may begin before biological death, but while the individual is in the process of death. If applied to the mortuary framework of the Baum Site, this also includes the processing that occurs within the charnel house. The final stage terminates the transition of identity with physical interment. Specifically, it is the formal dissolution of individual identity and reincorporation as the collective (Van Gennep, 1909).

In response to the recognized social identity and agency the deceased enact from the living, there is a social shift of the living that accompanies the transition from life to death, in whatever form of preparation that occurs (Hertz, 1907). An argument can be made that the inclusion of a few grave goods, such as the feline mandible and necklace of marginella shells, serve as evidence for a final acknowledgement of individuality. Despite its retrieval during excavation, uncontested associations between the grave goods and individuals are lost to taphonomic processes. Given this, a grasp of final identity for the intended individual(s) is reduced to a broad conceptualization of group identity, with the acknowledgement that there might have been a punctuated attempt to transfer individual identity to one that comprised the group.

Although hundreds of years removed from original inhabitation, the colloquial name that exists for the archaeological site and the individuals once buried on the land is derived from the family who acted to salvage the remains. The amount of media coverage that followed the discovery and excavations further solidified the persistent identity of the Baum Site. Conversely, the Office of State Archaeology assigned the identifier 31CK9 to the site in accordance with state, county, and site regulations (Phelps, 1980).

Upon salvage of the ossuaries, East Carolina University and the institution's faculty became the immediate representatives of the individuals. Over the course of their curation at the University, portions of the ossuaries have been incorporated in theses and published studies. Despite having no federally recognized representation in the Department of the Administration and no agreements that can be made under NAGPRA law, analysis must be approved by the State Archaeologist who works for the Office of

State Archaeology and the Commission of Indian Affairs. By this measure, there is a multilayer and interactive administration dynamic, an agent, that serves to protect the collection and permit its use in bioarchaeological inquiry under approved circumstances.

Having almost entirely been comprised of disarticulated and commingled remains, the collection falls into a category of disparate data sets. Although the argument of atheoretical applications is discussed further in a later chapter, individuals of the ossuary are marginalized by bioarchaeology because of the complex nature of their burial (Mant and Jaagumägi Holland, 2019). In addition, the Eurocentric historical accounts created during the contact operate as an umbrella of information that has definite and indisputable biases. Although the historical records post-date the estimated and calibrated date of the Baum Site, in the context of accuracy, many aspects of the indigenous are filtered for the Western reader. This effectively paints the indigenous as the "other" by the simultaneous sensationalism of their existence and introducing reductionist thoughts that perpetuate ill-conceived ideas of simplistic cultures by the more powerful culture (de la Cova, 2019).

CONCLUSION

This chapter has aimed to interpret the significance the paleodemographic data presented in the previous chapter. The wide scope of contextualization has a series of foci: archaeological interpretations of the site, previous paleopathological research and framework limitations, the influence of European histories, and finally, structures that impact the formulation of identity, agency, and marginalization. Although a wide net of

consideration is cast, it is a purposeful component of this research – the visibility not only of a site or a complex burial, but the individuals that give that site meaning. Bioarchaeological inquiry cannot and should operate to an end. There is room for improvement at every turn, especially for those that are relegated as an “other.”

CHAPTER EIGHT: CONCLUSION

This thesis was organized to solve several specific archaeological and bioarchaeological problems about the Baum site and to draw broader attention to the methodological and theoretical constraints that impact analysis of complex, commingled burials. In order to set the stage for a paleodemographic reconstruction that includes estimations of age-at-death and of the number of individuals within each burial at the Baum Site, the first four chapters reviewed the methods that have contributed to the body of knowledge that make bioarchaeological analysis of commingled remains possible – including the methodological approaches that have been slow to develop or are recent innovations. In addition, these chapters provided the historical and archaeological background that informed and contextualized living-dead interactions between descendants and ancestors. In light of the advancements that make this thesis possible, it is necessary to note that the marginalization of these individuals extends beyond the long-held belief that ossuaries represent a hard fought or inaccessible data set. Rather, there exists a persistent and overarching historical structure that inhibits the identity of the individuals and the collective group today, which limits manifestations of empowered agency on behalf of the group, and thus marginalizes the individuals further.

SUMMARY OF FINDINGS

The purpose of this thesis was to establish a modern paleodemographic reconstruction of the Baum Site, including age-at-death estimations and an estimation of the number of individuals within the commingled burials. The research hypotheses suggested that (1) the application of Most Likely Number of Individuals (MLNI) tools would establish a more robust estimate of individuals within the ossuaries. It was determined that analysis would be conducted on the three ossuaries that were, at minimum, partially intact by the time excavation began.

Burial 1 produced the best outcome for MLNI status. In fact, it corroborated the number estimated via the Minimum Number of Individuals (MNI) technique. Burial 5 and Burial 7, however, produced Highest Density Ranges (HDR) that were too narrow at the closest possible 95% threshold, likely resulting in underestimation. Despite this disconnect, the estimated recovery probabilities of the elements are an interesting addition to the understanding of the impacts of erosion and burial destruction.

The final two research hypotheses centered around age-at-death. This included (2) a projection that age-at-death estimations would provide evidence for the inclusiveness of the burial and (3) that the elimination of cranial scores would result in more precise age-at-death estimations. The results of transition analysis were unable to reject the first hypothesis. These ossuary burials did not exclude the deposition of individuals based on age. Further evidence for this conclusion is based on the archaeological records that

indicate spatially distinct clusters of subadult remains distributed throughout the ossuary, as previously contextualized and associated with the marginella shell necklace.

The results were also unable to reject the second age-related hypothesis. Although it eliminated data that is known to inform age based on cranial suture obliteration, the elimination of cranial fusion scores tended to remove "outlier" estimated age ranges. As a result, estimates tended to fall within more concise and realistic ranges in which the true age had the greatest likelihood to be found.

The influence of European histories exists as an important context in which historical and modern connotations of collective identity, agency, and marginalization are rooted. As early conceptualizations of indigenous life and culture were circulated, the fallacies that existed from intentional or negligent censure were rampant. As a more powerful entity, such fallacies are weaponized by structurally violent relationships, as evidenced by the creation and forceful movement of indigenous to reservation land. The later opportunity to sell the supposedly protected land further ensured the eventual native removal altogether.

Bioarchaeologists are uniquely situated to identify disparities of resources as they present in the archaeological or biological context – both in life, and in ancestor/descendent living-dead interactions. Recently, an extension of this realization exists in the disparity between modern agents of power and the deceased – again, another living-dead interaction. Beyond the marginalization of the individuals of the Baum Site for existing as a perceived disparate data set, there is no empowered representation working on behalf of the deceased. There is no state validated or supported identity for

these individuals, and this severely limits motivation to affect change on behalf of the deceased. Instead, the University and Office of State Archaeology assume the role of protector. While they have succeeded in that role, it also does not necessarily equate to advocacy, however.

The elucidation of the multi-layered structures that impose control are meant to draw visibility to not only the issue, but the individuals studied in this work. As a reflexive discipline, there is an opportunity to identify the deeper structures that influence bioarchaeological interpretation and the living-dead interactions that exists between the researcher and the deceased. By this measure, bioarchaeology can exercise a far greater humanity and mindfulness in the work that is produced.

FUTURE DIRECTIONS

Given the complexities of commingled remains, methods and theory have historically been clearly limited. This does not, however, preclude avenues that should be explored. Specifically, an extension of the already complex practice of archaeothanatology may find utility in retroactively refitting excavation notes and maps to this level of excavation and spatial inquiry. Given commingled remains are already considered the most complex burials, this foundation has opportunity considering the new scanning technologies that capture the excavation in 3D renderings (Duday, 2006).

Unlike the overarching message of archaeothanatology as “field anthropology,” interpretation of mass burials are often better reserved for the dual synthesis of burial

contexts in the field and anatomical reconstructions that are applied in laboratory work. In a scenario where individuation can be discerned, archaeothanatology has two goals: (1) to understand the conditions that preserve articular relationships and, (2) to explain the displacement of skeletal elements if they are no longer in anatomical position. These articulations are known as a relationship of the first order (Duday, 1987b; Duday, 2006). Because the primary articulation is removed by the nature of the burial, analysis of mass burials moves to relationships of the second order (Duday, 2006). This still depends on the identification of associated elements to indicate the distribution of a single individual throughout the burial context. The way the associations are made harken back to guidance provided by Adams and Konigsberg (2004) involving pair matching.

Relationships of the second order can be evaluated in a variety of ways. These include relationships by conjoined fragments, contiguous articulations, stage of development, same pathological expression of a localized lesion, and finally, bilateral pair-matching based on symmetry. Conjoined fragments depend on refitting fragmented pieces to represent a single individual. Contiguous articulations depend on the complex morphology of articulation that might be unique to each individual. Cranial sutures are an example of such articulations. Development stage depends on the identification of elements that are in a development stage that correspond to the same ages. This use is limited, however, when multiple independent elements are around the same stage of development, and thus, age-at-death. Relationships based on skeletal pathological conditions depend on the expression of the lesion on more than a single element, and something that is unique enough that it would not be mistaken and descriptively labeled

as a degenerative marker (e.g., Klaus, 2017). Finally, matching by symmetry depends on an understanding that no two elements are symmetrical. Rather, pair-matching depends more on the understood correlation between size, shape, robusticity, and weight – all of which can be externally impacted if lesions are present. Any existence of known associations within the burial can also be marked beforehand as an *a priori* assumption of a common relationship.

In direct opposition to Adams and Konigsberg (2004), Duday suggests that smaller elements, such as the patellae and other small bones, such as the carpals, tarsals, metacarpals, and metatarsals, offer the best insight. Acknowledging the traditional focus of archaeologists on certain more "'noble'" elements, such as the crania, mandible, and other large bones, the smaller elements tend to go unnoticed and unemployed in comparisons (Duday, 2006).

Instead, archaeothanatological methods may permit an interpretation that considers the distribution of elements within the ossuary to indicate "hot spots" of regions with dense skeletal representation. As outlined in a later publication, (Duday, 2009), such "hot spots" might be the locations of decomposition, where smaller elements were unrecovered for secondary interment. In addition, "retrofitting" or otherwise *post-hoc* application of archaeothanatological methods to plan maps and field notes may shed light on the pattern of long bone internment, since field notes indicate that they were leaned against the cut wall. Placement may symbolize collectiveness by quite literally surrounding the remaining elements in long bones, but it may have also assisted in the structural integrity of the pit. Because archaeothanatology perceives that elements within

a burial exist in the way they do, and are discovered in specific positions for a reason, the distribution of dense areas might offer a glimpse of patterning within the remains – both laterally, vertically, and based on the variables of estimated sex, estimated age-at-death, and possible association with grave goods. An example of such patterned distribution correlate to the discovery of concentrated deposits of small skeletal elements.

CONCLUSION

The completion of this thesis offers insight to the preliminary methods that are amenable to even the most complex of burials, as seen in the ossuaries of the Baum site. From a history of marginalized data and debated usefulness of paleodemographic research, the data presented here offer hopeful insights for future research. In addition, the robust paleodemographic data both corroborate the archaeological data, previous literature, and further strengthen the understanding of living-dead interactions – both in inclusion, creation of the ossuary, and greater symbolism associated with a "cemetery." In addition to the bioarchaeological data, an overarching identification of structures that impose power on already marginalized groups of peoples permit room for visibility, reflexivity, and a more mindful living-dead interaction – for both researchers within the discipline, and individuals that hold privilege and influence our social narratives as we make sense of the past and present.

APPENDIX

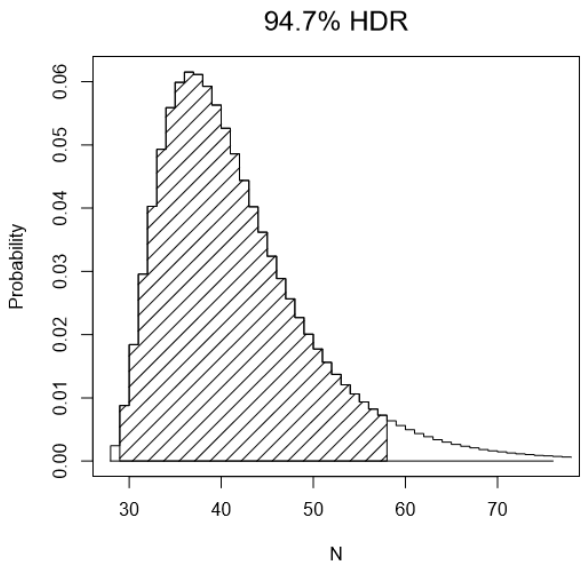

Figure A.1. Burial 1, Highest Density Region (94.7%) of the Humerus

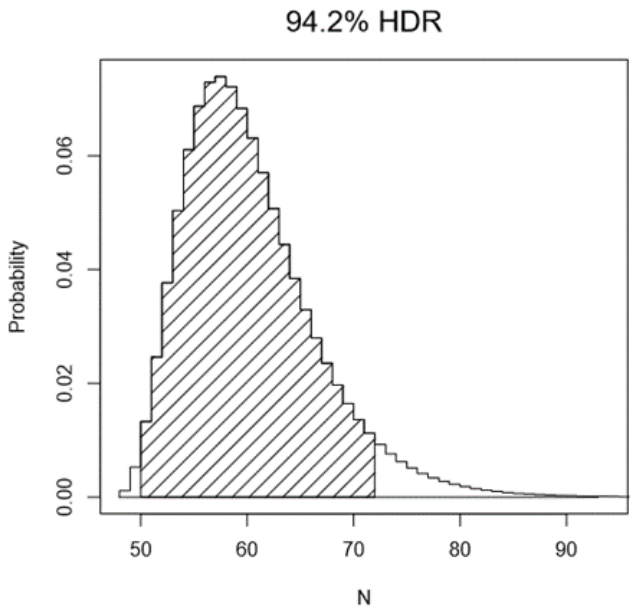

Figure A.2. Burial 1, Highest Density Region (94.2%) of the Femur.

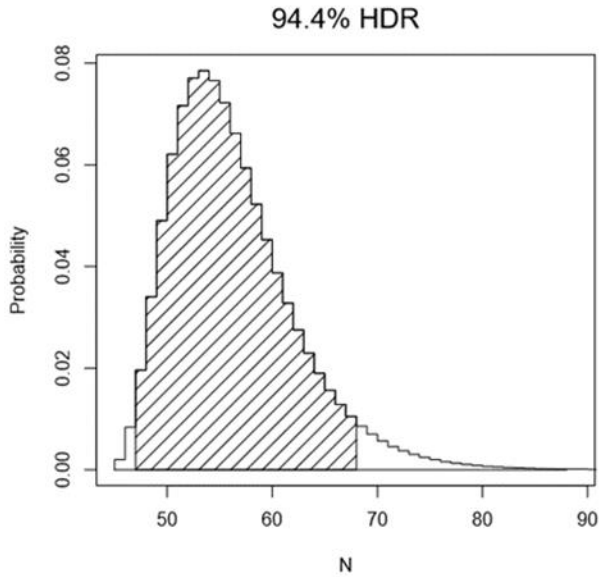

Figure A.3. Burial 1, Highest Density Region (94.4%) of the Tibiae.

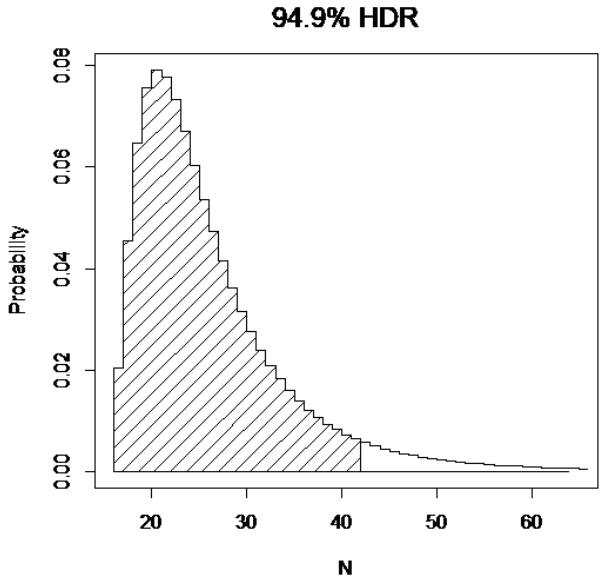

Figure A.4. Burial 5, Highest Density Region (94.9%) of the Humerus.

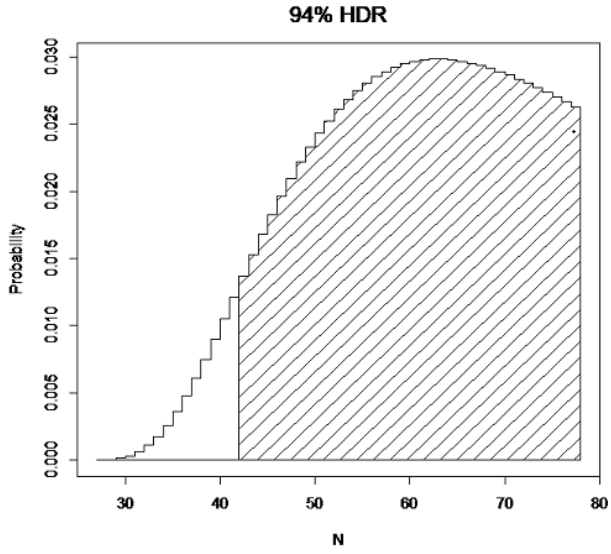

Figure A.5. Burial 5, Highest Density Region (94%) of the Femur.

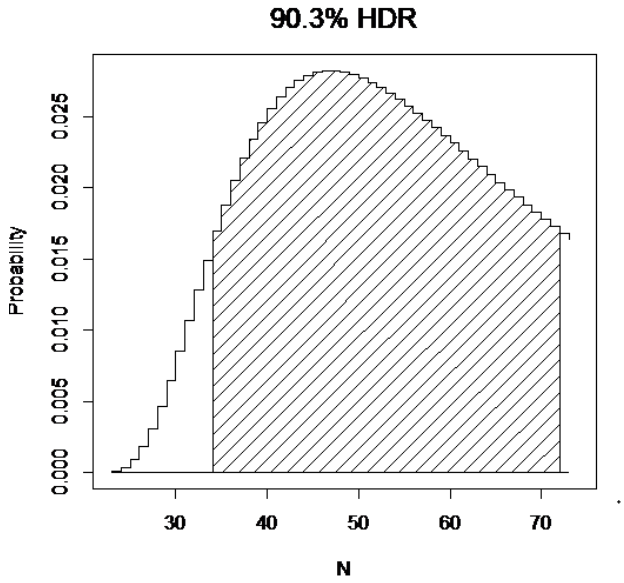

Figure A.6. Burial 5, Highest Density Region (90.3%) of the Tibiae.

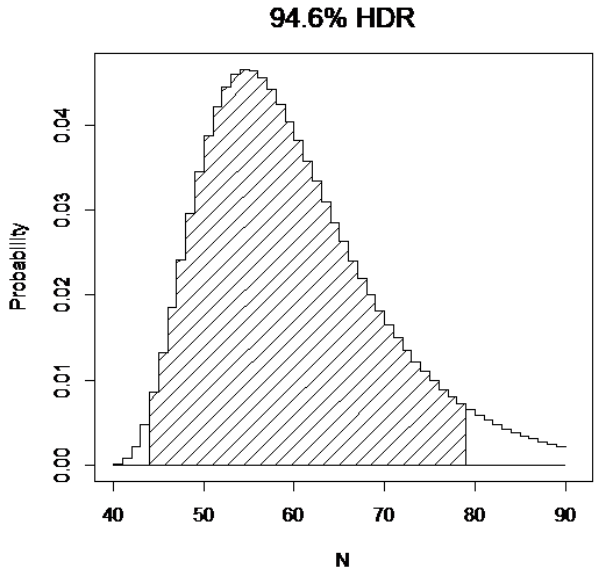

Figure A.7. Burial 7, Highest Density Region (94.6%) of the Humerus.

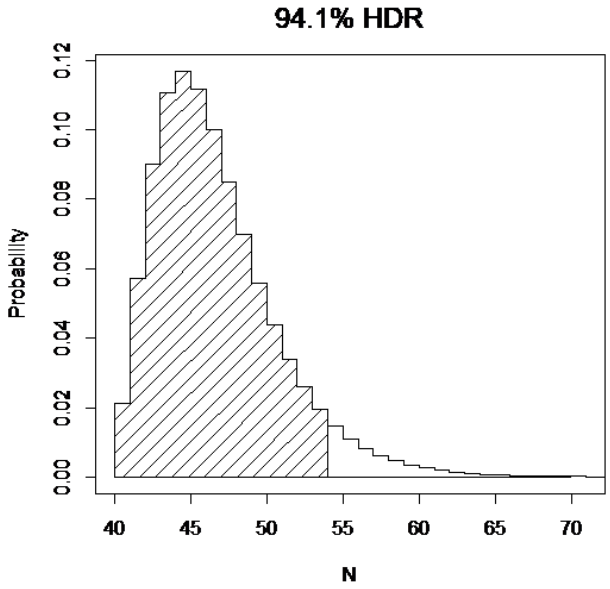

Figure A.8. Burial 7, Highest Density Region (94.1%) of the Femur.

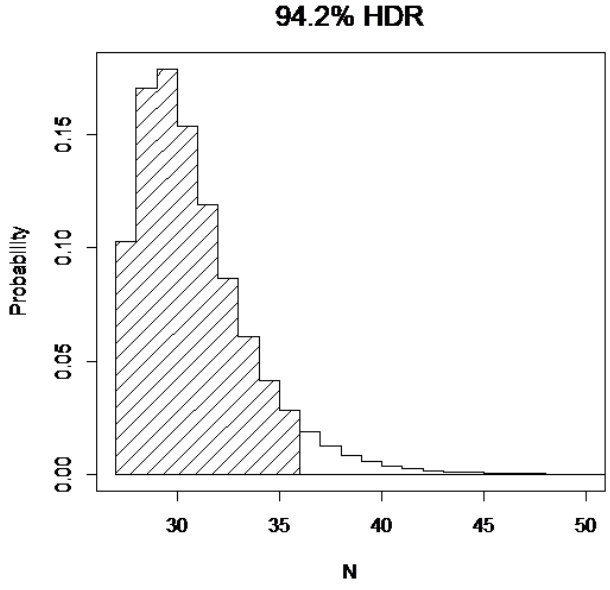

Figure A.9. Burial 7, Highest Density Region (94.2%) of the Tibiae.

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