Abstract

Previous research on Late Woodland North Carolina has explored how transitions such as agricultural intensification or the arrival of European settlers have impacted the biology of coastal populations. This thesis details the health and disease of the recently excavated burials at the West site in Currituck, NC, as a means of further understanding biological adaptation in this microenvironment. The study employs biological data and material culture to examine various hypotheses for utilizing primary vs. secondary burials at Currituck and at other sites with similarly multifaceted burial records. It further investigates patterning at the intra- and inter-site level – in terms of health, demographic variables (age, sex), location, and other aspects of mortuary treatment (e.g., grave goods) as a means of reconstructing the range of bio-social identities at these sites.

A Comparative Analysis of Paleopathology and Mortuary Practices at West Site (31CK22), Currituck County, NC

A Thesis/Dissertation

Presented To the Faculty of the Department of Anthropology

East Carolina University

In Partial Fulfillment of the Requirements for the Degree

Master of Arts

by

Lauren Souther

April 28, 2014

© Lauren Souther, 2014

A Comparative Analysis of Paleopathology and Mortuary Practices at West Site (31CK22), Currituck County, NC

by

Lauren Souther

APPROVED BY:

DIRECTOR OF
DISSERTATION/THESIS: _____
(Megan A. Perry, PhD)

COMMITTEE MEMBER: _____
(Edmond A. Boudreaux, III, PhD)

CHAIR OF THE DEPARTMENT
OF (Anthropology): _____
(I. Randolph Daniel, PhD)

DEAN OF THE
GRADUATE SCHOOL: _____
Paul J. Gemperline, PhD

Acknowledgements

There are a number of people that I would like to acknowledge and thank. I would first and foremost like to thank my advisor Dr. Megan Perry. Her guidance and advice both in regards to my thesis, education, and general life problems have helped me immensely. I am also grateful to my other committee members Drs. Randy Daniel and Tony Boudreaux for not only their participation as members of my thesis committee, but also for being patient for the time it took for me to complete my thesis.

I would like to thank everyone at the North Carolina Office of State Archaeology for their eagerness to help me with my research and doing everything they could to make my research efforts easier. I would also like to thank Dr. Dale Hutchinson for pioneering the research on the health and mortuary practices of Outer Coast North Carolina, as well as for supplying data to aid me in my research.

There are a number of other people that I would like to acknowledge for their support and motivation in the years leading up to graduate school. Dr. Mary K. Sandford was the professor whose dedication and enthusiasm for bioarchaeology inspired me in my undergraduate program, and I will always be forever grateful. To my parents, Ricky and Nanci, your work ethics have always been an inspiration to me. You guys were always supportive of my decision to study archaeology, helping me travel to places all over the world in pursuit of these archaeological adventures. I love you both, even if you guys still think I dig up dinosaur bones for a living.

Finally, to my sister Nicole, my rock and my best friend, what would I do without you? You have been there for me through just about everything. You remain an inspiration to me and are someone I constantly strive to live up to. Remember how you once said that you admired me

for my determination for sticking with an archaeology program despite the constant ridicule from others? Well, I did it!

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

Research on the Late Woodland period (AD 800-1650) inner and outer coastal sites in North Carolina has emphasized this period's uniqueness within the state's prehistory. The transition from the Middle to Late Woodland saw an overall shift away from a reliance on hunting and gathering to increased dependence on agriculture in inner and outer coastal groups. The numerous and varied microenvironments within this region makes the study of subsistence practices, health, and nutritional status of these prehistoric groups a complex enterprise. Previous excavation and research by Dale Hutchinson (2002), Mark Mathis (1994), and Billy Oliver (1984) has explored how transitions such as agricultural intensification or the arrival of European settlers have impacted the biology of Inner and Outer Coast inhabitants. Hutchinson (2002) specifically turned to human skeletal material recovered from coastal Middle and Late Woodland sites to explore how the reliance on maritime resources affected the timing and degree of agricultural intensification, how the increased consumption of domesticated maize impacted health and disease in Late Woodland populations, and how disease and nutrition differed between populations relying on agriculture versus marine hunting and gathering. The primary goal of this thesis research is to further investigate the health and disease of burials excavated in 2010 at the outer coastal West site in Currituck, NC. The human remains previously excavated from the site were included within Hutchinson's study of diet and paleopathology of Late Woodland outer and inner coastal sites. Increased sample size from this outer coastal site will expand our understanding of biological adaptation in this microenvironment

In addition, the 2010 excavations revealed diverse burial patterns at the West Site. This study thus includes using biological and material cultural data to tease out possible explanations for utilizing primary vs. secondary burial at the site and at other outer coastal Late Woodland

sites with similarly multifaceted burial programs. Other instances of articulated primary burials from the region were explored to identify intersite patterns by burial practice in terms of health, demographic variables (age, sex), context, and other aspects of mortuary treatment, e.g., grave goods, etc. that would explain the different mortuary treatment.

A study of paleopathology and mortuary practice comparisons of the recently excavated burials at the West site was expected to produce results congruent with previous work of Dale Hutchinson. The first was that there should be signs of nutritional stress, and/or disease consistent with previously studied coastal burial sites. The pathologies listed in the background and methods section are all conditions that have been observed by Dale Hutchinson in outer coastal North Carolina Late Woodland skeletal remains. Another expectation was that there should be no significant difference in health status between individuals buried in primary versus secondary burials at West, as well as in the wider coastal burial program. As well, it was expected there should not be any significant difference between males and females in health status. There should also not be any significant difference between which sex was buried in primary or secondary burials. Finally, there was an expectation that one could establish that Burials 4 and 5 were in fact primary burials and were part of a larger burial ritual involving the secondary burials at West. Primary burials at the site will be classified by the presence of articulated burials while the secondary burials at the site will be classified by the presence of bundled and scattered skeletal remains of multiple individuals.

The following chapter provides an outline of what is currently known regarding Late Woodland period outer coastal sites of North Carolina, including the archaeological characteristics of the period and the history of the excavations. This is followed by a brief description of what bioarchaeology and paleopathology are and what they seek to explain about

archaeological populations. The methodology section will outline the techniques used in this study to assess health and adaptation of the individuals buried at the West Site. This is followed by the data collected in the study of Burials 4 and 5, as well as the data collected from the reanalysis of Burial 1. Finally, a synthetic discussion of the burials at West, as well as the other contemporary outer coastal sites will illuminate any patterns of the paleopathology data and mortuary activity of the Algonkians during the Late Woodland.

Chapter 2: Background

Understanding Late Woodland period (AD 800-1650) health, disease, subsistence, and mortuary practices requires recognizing the unique contexts within which the Algonkians lived during this period. The history of the excavation and the burials found at the West sites 1 and 2 (31CK22) lays the framework for the previously-outlined expectations of the new burials excavated in 2010, Burials 4 and 5. In order to put these research expectations into context, this section will delve into an overview of the different coastal sites in North Carolina with primary and secondary ossuary burials. This section will conclude with what bioarchaeology and paleopathology are and why these fields are important in evaluating nutritional status and disease in understanding past populations.

Environmental Setting

The Coastal Plain generally is divided into northern and southern regions (Daniel 1999:4). The northern region runs from Cape Lookout on the Outer Banks across the mainland to the Neuse River and expands north to the Virginia state line. The southern region extends south of the Cape Lookout – Neuse River boundary to South Carolina (Phelps 1983). This coastal region can be further divided into the northern coastal plain (Inner Coast) and the northern coast (Outer Coast). Individuals within these separate geographic regions also differ ethnohistorically based on material culture and European historic accounts. The populations investigated here reside in the southern end of the northern Outer Coast, inhabited by Algonkian-speaking groups when European contact occurred (Daniel 1999:4).

The diverse and rich freshwater and saltwater habitats comprised by a variety of rivers, sounds, and oceans strongly impacted the response of Late Woodland populations as neighboring populations began relying largely on agricultural production, as described below.

Figure 2.1 Map of Algonkian Outer Coast sites including West (31Ck22), Baum (31Ck9), Hatteras (31Dr38), and Knotts Island (31Ck24) (from Hutchinson 2002:18).

.

The Late Woodland Period

The Woodland period can be divided into three distinct archaeological time periods: the Early Woodland (1000-300 BC), the Middle Woodland (300 BC-AD 800), and the Late Woodland (AD 800-1650) (Ward and Davis 1999). The Late Woodland period in coastal North Carolina is characterized by the emergence of the linguistic, cultural, and physical differences observed by the Europeans upon their arrival in the region (Hutchinson 2002:19).

During the Late Woodland, the coastal region of North Carolina was dominated by Algonkian-speaking groups. One identifying characteristic of the Late Woodland Algonkians is the Colington phase of ceramic production. The majority of the surfaces of Colington series pottery is fabric-impressed, followed in popularity by simple stamped, plain, and incised ceramics (Phelps 1983). This series of pottery is believed to be culturally-influenced by the Townsend series and the Roanoke Simple Stamped ceramic type of southeastern Virginia which possibly implies some cultural and/or genetic relationship with the coastal North Carolina Algonkians (Phelps 1983; Ward and Davis 1999).

The settlement pattern of the Colington phase Algonkians is difficult to typify. Through the 800 or so years that comprise the phase, a great deal of variation in the size, function and distribution of settlements existed (Ward and Davis 1999:211). At the time of European contact, villages consisted of longhouses that were sometimes surrounded by palisades (Hutchinson 2002:19). The archaeological evidence of these villages is somewhat limited. However, there exist brilliant drawings of Algonkian villages by the early English explorers of the Raleigh expeditions, in particular the detailed watercolors of John White (Hutchinson 2002:19). The two outer coastal villages that White illustrated are fairly different in their architectural plans. The village of Pomeiock, on the mainland side of the Pamlico Sound, is depicted as a cluster of

longhouses surrounded by a palisade. The second village of Secotan, on the south bank of the Pamlico River, is shown with longhouses along a central path with three cornfields and no palisade walls (Hutchinson 2002:21). However, both depictions make it evident that the longhouses were the standard residence of the Late Woodland Algonkians, at least at the time of European contact.

The typical and most visible type of burials for the Late Woodland is the secondary collective mass burials in graves known as ossuaries (Hutchinson 2002:21-23). Colington phase Algonkian ossuaries generally contained between 20 and 60 people in various states of articulation with a majority of individuals completely disarticulated (Hutchinson 2002:23). These ossuaries do not show any signs of burial differentiation by age or sex, and grave goods are scarce (Hutchinson 2002:23). Single primary burials also exist in association with these sites, but have not been as well recorded as ossuary sites. They are most likely part of a larger ritual process that ultimately results in ossuary burial (Hutchinson 2002:23). While the study of the skeletal remains is important in gaining an understanding of prehistoric populations, the study of mortuary practice and variability is also essential in inferring social organization and complexity (O'Shea 1984:1). Demographic studies utilizing mortuary data, as well as biological data, are used increasingly to better understand past societies. In regards to prehistoric populations in North America, it is possible to use biological data, mortuary data, and ethnohistoric accounts of the Europeans to gain a better understanding of the mortuary practices at the time of contact. While ossuary burials are characteristic of both Inner and Outer Coast regions, the study of the primary and secondary burials at West offers a window into the burial practices being used by the Algonkians by the Late Woodland period.

West Burial Sites (31CK22)

West #1 and #2 were ossuary burials located near Currituck in Currituck County (Figure 2.2) that were recovered intermittently since the 1980s by Office of State Archaeology and East Carolina University archaeologists (Figure 2.3). Both burials were discovered eroding into the Currituck Sound, and as a result, excavations were rescue efforts to salvage the remaining skeletal remains from eroding into the sound.

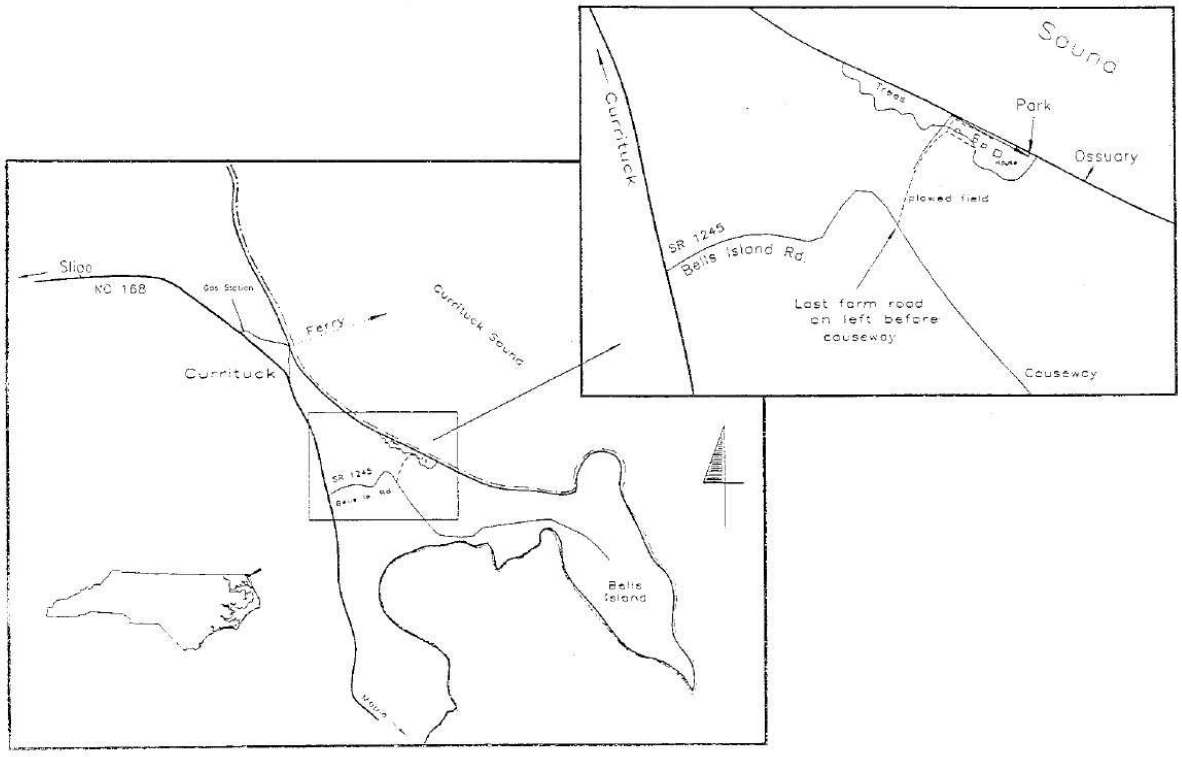

Figure 2.2 Location of West Site, 31CK22

Figure 2.3 Aerial Photo showing locations of West Site's Burials 1, 2, 3, and 4 (Google Earth, 2014)

West burial #1 was excavated October 8-14, 1984. This excavation was a salvage project carried out by Billy Oliver and Paul Green of the Office of State Archaeology, assisted by East Carolina University archaeologists. The ossuary was recorded as containing the remains of at least five individuals and Late Woodland Colington phase artifacts. Billy Oliver reported that the *in situ* remains seemed to have been deposited as discrete bundles rather than a single deposit. Colington ceramics were also recovered from just above the burial pit, and it was presumed that the remains were associated with this period of the prehistoric past, ca. AD 800-1650 (letter to Tom Burke, Oct.25, 1984 at Office of State Archaeology). The human skeletal study that was conducted by R.D. McCall and Mark C. Griffin in 1985 concluded that the five adults were male with the exception of one possible female as indicated by cranial and innominate bone features and that their ages ranged from late teens to 35 years. The pathologies noted in the report include an abscess from premortem tooth loss, and periosteal reactions of three long bones (left tibia, left

fibula, and another unsided fibula) (McCall and Griffin 1985). It should be noted that the minimum number of individuals in this earlier report appears to have excluded the subadult remains in its calculation, which will be discussed in more detail in the results section.

West # 2 (31CK22) is an ossuary that was exposed in a high bank approximately 2.5 meters above the beach and 0.70 meters below the current land surface (Mathis 1992). The site was excavated in 1994 by Mark Mathis to salvage the ossuary, of which half had been lost to erosion into Currituck Sound. A large portion of the remains were disarticulated and scattered, most likely due to postmortem activity. However, 13 discrete areas of remains (bundles) were recorded during excavation by Mathis (Hutchinson 2002:37). There were red cordage stains evident on many of the crania, most likely due to the remains being stored in mats or chests that were painted with red pigment, as well as bone pins that were similar to those found at sites such as Baum, an outer coastal site contemporary with West. Although there are no radiocarbon dates for this site, two facts suggest that it dates to the Late Woodland: (1) no ossuaries known in the mid-Atlantic predate the Late Woodland period, and (2) the artifacts included inside the burials are typical of the Late Woodland Colington collections

A third burial site, West #3, was thought to exist based on records at the Office of State Archaeology. Upon further investigation, it became clear that these remains initially identified and collected as Burial 3 were combined with Burial 2.

Other Outer Coastal Sites

The recoveries of skeletal remains from the outer coastal sites were, for the most part, salvage excavations. In the majority of instances, the bones were eroding out of bluffs along the

inner sounds. As with the West burials, the excavations of the other outer coastal sites in this study were carried out by the Office of State Archaeology and archaeologists from East Carolina University. The majority of coastal ossuaries had already eroded to some degree, and the skeletal collections represent only a portion of the total individuals interred (Hutchinson 2002:31). These studies can contextualize information from the West site in terms of the health and adaptation of outer coastal population. The brief descriptions of other outer coastal sites that follow allows for comparisons and similarities to be drawn between the West site's primary and secondary burials and other sites' burial practices and health statuses of the buried individuals.

The Baum site (31CK9) is located north of the town of Poplar Branch in Currituck County. It is approximately five acres in size and is on the mainland alongside the Currituck Sound. The Middle and Late Woodland site consists of a large permanent village with an associated shell midden and several ossuary and individual burials, in addition to a historic cemetery (Hutchinson 2002:32). Excavations of five ossuaries and several single and multiple burials were carried out by David Sutton Phelps of East Carolina University between 1972 and 1987. One burial, Burial 8, was excavated by Mark Mathis of the Office of State Archaeology. The associated material remains date the site to just prior to 300 BC, but the majority of artifacts point to maximum site occupation in the Middle and Late Woodland periods. Most of the burials are associated with the Late Woodland Colington phase, One radiocarbon date was obtained from organic materials from Test Square B, which was AD 1315 +/- 70 (Hutchinson 2002:33). Burial 1, a Late Woodland burial, was the first relatively intact burial that was excavated. The burial contained several bundle burials (the gathering together of long bones into groups), scattered bones, and eight articulated burials. Burial 2 was a Middle Woodland cremation. Burial 3 was a flexed Middle Woodland burial of an individual that was found beneath Burial 2. Burial

4 was a fragmentary subadult burial. However, additional material was recovered from an eroding bank in 1980 and was included with the subadult, after it was determined that the remains belonged to the same individual. Burial 5 was a partial Late Woodland ossuary. Burial 5 had been eroded by waves before excavation commenced, and, Phelps estimated that perhaps one-quarter to one-third of the pit had been destroyed by erosion (Phelps 1980). There were three fully articulated burials recovered in the pit, as well as two or three bundle burials; the remainders of the bones are disarticulated and could not be associated with any of the burials. Among the numerous artifacts found in Burial 5 was a small necklace of 15 marginella shell beads and one disc-shaped copper bead. Burial 6 was a fragmentary Late Woodland ossuary that had eroded out onto the beach. Burial 7 was also a Late Woodland ossuary exposed by erosion; four crania showed evidence of red staining. Burial 8 was a Middle Woodland burial of at least three individuals, which were dated on the presence of Mount Pleasant ceramics (Hutchinson 2002:35-36).

Hatteras Village (31DR38) is located on Hatteras Island. It is an eroded ossuary that was excavated in 1974 by David Sutton Phelps. The ossuary has a radiocarbon date of AD 1350 ± 70, placing it in the Late Woodland period. The ossuary appeared to contain an estimated 38 individuals (Hutchinson 2002:36).

Knott's Island site (31CK24) is located in Currituck County near the town of Knott's Island and was excavated in 1989 by Mark Mathis. The ossuary contained an estimated 29 individuals. The site is dated to the Late Woodland Algonkian based on the shell tempered pottery sherds found in association with the burial (Hutchinson 2002:37).

Dale Hutchinson noted that before his studies, there has been very little bioarchaeological research into the uniqueness of coastal adaptations and the biological effects of the maritime

environment and resource consumption. He stated that prior studies of coastal populations have focused primarily on the biological consequences of cultural transitions, like the transition to agriculture, the rise of civilization, or the effects of European contact (Hutchinson 2002:11). The next section will address the definition of bioarchaeology and its relation to paleopathology and why they are important in the study of the human remains from the outer coastal sites such as the West site.

Bioarchaeology and Paleopathology

Bioarchaeology is the study of human remains from the archaeological record in order to gain a better understanding of demographics, health, and the overall lifeways of past populations. Bioarchaeologists make use of human skeletal remains to make behavioral suppositions about the past, as well as to infer the interrelationship of behavior and biology allowing reconstruction of nutrition and health (Larsen 1997). By studying human remains, archaeologists are equipped with insight into the economic strategies of past populations, which subsequently leads to understanding of the consequences of those strategies on their health (Hutchinson 2002:11).

The analyses of pathologies in ancient bone, or paleopathology, allows bioarchaeologists to better understand health and disease in the populations that they are studying. Paleopathology illuminates the evolution and development of disease through long periods of time and also reveals how humans adapted to alterations in their environment (Roberts and Manchester 2005:1). Methods used in paleopathological studies rely mostly on macroscopic observations of abnormal changes seen in the skeletal remains. However, additional methods used include radiography, microscopy, and other physical and chemical techniques.

Dale Hutchinson's research of outer and inner coastal burials demonstrates that in studying the health of past populations, it is necessary to not only record pathological lesions, but also incorporate the nutritional basis, diet quality, habitual mechanical behaviors, behavioral alterations, and a multitude of other variables that might influence the environmental and social context within which nutritional deficiencies and disease occur (Hutchinson 2002:82). Hutchinson used several dental and skeletal indicators to address these concerns. Dietary quality and infectious disease are interactive; if the quality of diet is poor, then the likelihood of infectious disease increases. They are assessed by observing the frequency of carious lesions, periodontal disease, premortem tooth loss, enamel hypoplasia, porotic hyperostosis, osteoarthritis, periosteal reactions, and osteomyelitis (Hutchinson 2002:83). Behavioral alterations can be evaluated by observing the frequency of external auditory exostoses, fractures and blunt cranial trauma, and dental chipping (Hutchinson 2002:83). This analysis of the newly recovered West burials explores the same pathologies observed by Hutchinson to broaden our perspectives of the health and quality of life of outer coastal North Carolinian populations during the Late Woodland period. However, it is integral to better understand what these pathologies are and how they relate to a more comprehensive evaluation of health at sites such as West.

Pathologies

Dental Caries and Periodontal Disease

Dental caries is an infectious disease where microbial activity on the tooth surface causes progressive destruction of tooth structure, root or crown (Ortner 2003:590). Caries of the dental root takes place as the root is exposed to cariogenic bacteria by periodontal disease. The dental

areas that are open to potential caries are (1) the cutting or chewing (occlusal) surfaces; (2) the smooth surfaces of the crown, including the mesiodistal surfaces in contact with other teeth and buccolingual surfaces; and (3) the root, which may be directly affected by caries after the recession of the supporting bone and gingiva (Ortner 2003:590). In distinguishing an early stage cavity induced by dental caries from a natural pit, one must observe that when caries passes through the enamel and reaches the dentin, the destructive course spreads rapidly in the dentin. This will create a funnel-shaped lytic lesion (Ortner 2003:590).

Periodontal disease occurs when gingivitis (inflammation of the gums) goes untreated (Ortner 2003:593). This disease is an inflammatory response to one or more irritations. The inflammation often results in slight to severe resorption of the alveolar process, which creates an atypically large distance between bone and the cemento-enamel junction of the tooth.

Dental Damage and Modification

There are many ways in which teeth may be damaged. Dental damage can occur when there is a blow to the face. Additionally, biting on hard materials, abrasion caused by gritty foods, and abrasion to the teeth from chronic biting on a pipe, or the use of teeth as a supplemental tool in some occupational action can fracture the enamel (Ortner 2003:602). The enamel, dentin, pulp, and cementum can be involved in fracture; in the majority of cases the crown is more likely involved (Ortner 2003:602). Diet can be reconstructed based on the dental wear and damage observed. The dietary reconstruction can be enhanced by the observance that within a given age group, more extreme attrition is associated with coarser food consumption (Buikstra and Ubelaker 1994:49). If there is a significant reduction in dental wear, it is most

likely associated with the introduction of agriculture. This introduction indicates reduced coarseness of the diet as well as a change in food composition and preparation.

Dental Enamel Hypoplasias

Hypoplasias of the teeth can occur when there is disturbance in growth in childhood, such as nutritional stress, which causes a disruption in enamel formation. For such a defect to develop in permanent teeth (excepting the third molar), the stimulating cause must occur before age 6 (Ortner 2003:595) and the individual must have resumed normal enamel formation (and thus survived the stressful period). A measurement can be taken with sliding calipers from the location of the dental enamel hypoplasia from the cemento-enamel junction to calculate an age range at which the stress occurred (Goodman and Rose 1990).

Porotic Hyperostosis

Porotic hyperostosis is a descriptive term for any porous enlargement of bone tissue or expansion of the diploe in the cranium (Ortner 2003:55). Porotic hyperostosis of the skull is frequently linked to a form of anemia. However, porotic hyperostosis can also be caused by infection or scurvy. These causations can be differentiated from anemia by the morphology of the lesions; in scurvy or infection, the cross-sectional morphology displays lesions that are superficial to the outer table (Ortner 2003:56). In these instances, there is no significant change in the diploic space or outer table. The lesions associated with anemia are most often found on the cranial vault, primarily affecting the outer table of the parietal bones, and the orbital roof (often referred to as *cribra orbitalia)* (Ortner 2003:371). These consist of porous, periosteal bone

formation in these areas. The different types of anemia that this pathology could be attributed to are thalassemia, sickle cell anemia, and iron deficiency anemia. The latter, which is due to inadequate iron absorption, a sign of nutritional stress is the more likely to be the attributed disease in this archaeological population based on previous research on skeletal remains (Ortner 2003:373).

Periosteal Reactions

Periosteal reactions and osteomyelitis are skeletal responses to excessive physical stress, systemic infection, or trauma (Ortner 2003:87-88). Osteomyelitis is most often caused by the introduction of pyogenic bacteria into the bone (Ortner 2003:181). The infection agents can reach the skeleton by different routes: (1) direct infection through trauma or surgical wounds, (2) direct extension from adjacent soft tissue infections, or (3) by the hematogenous path from a remote septic focus (Ortner 2003:181). There are many types of osteomyelitis, but in most cases, infection is limited to the periosteum and cortex.

Periostitis represents a reaction of the bone periosteum to pathologic changes of the underlying bone (Ortner 2003:206). Undifferentiated and nonspecific periosteal lesions of long bones are among the most common abnormalities found in archaeological skeletons. As with osteomyelitis, periostitis is part of a disease syndrome (such as syphilis), and it is also a specific disease itself (Ortner 2003:207-208). Primary periostitis is most frequently the result of two pathological conditions, trauma and infection. Periostitis, as a result of trauma, is brought on by sudden or chronic insult to the bone (Ortner 2003:208). One the most common sites of periostitis in archaeological remains is the diaphysis of the tibia. There is still much debate about the cause of this condition on this particular aspect and element, but it is important to note that periosteal reaction in syphilis forms on bones that are near the skin surface (such as the tibia or cranial

vault) (Ortner 2003:209). The distinction between periostitis and osteomyelitis cannot always be made in dry bone. However, with periostitis there will be no cloacae, involucrum, or changes in the marrow cavity. Additionally, pathological periosteal bone tends to be superficial to the normal cortex, at least in the early stages of the disease (Ortner 2003: 209-210).

External Auditory Exostoses

External auditory exostosis most often occurs in archaeological populations who regularly dive for marine food sources. Exostoses are caused by continuous exposure to cold water and/or wind. If exostoses are observed in the outer coastal populations, this would support a mainly marine source diet, or at the very least, that they were responsible for gathering marine food sources.

Specific Infectious Diseases

Infectious diseases can sometimes be difficult to diagnose in skeletal remains, since most infectious diseases only cause pathology if an individual has a chronic case of the disease, or do not have a distinctive enough pattern for differential diagnosis (Ortner 2003:110). Therefore, absence of skeletal disease evidence could indicate: (1) the person may have died of a disease that does not affect the skeleton, (2) death could have occurred in a disease that could have eventually caused skeletal lesions and abnormalities, (3) the immune response of the exposed host can eliminate or control the pathogen before skeletal disease could occur (Ortner 2003:110). Specific infectious diseases can manifest themselves in one of three ways in the skeleton and sometimes a combination of more than one: lesions pathognomic for disease, (2) the presence of

cloacae (openings for pus drainage), (3) similar lesions for multiple elements of a single individual.

Degenerative Joint Disease

Osteoarthritis has three major components of skeletal involvement: (1) the breakdown of articular cartilage, which could result in bone on bone contact and abnormal abrasion of the subchondral bone, (2) reactive bone formation (sclerosis) in both the subchondral compact bone (eburnation) and in the trabeculae, and (3) new growth of ossified cartilage and bone at the joint margins (osteophytes) (Ortner 2003:546). There are two types of osteoarthritis that are recognized: primary osteoarthritis, which often occurs later in life as a result of multiple factors such as trauma and biomechanical stress, and secondary osteoarthritis that develops early in life in joints that are abnormal due to other pathological conditions. If osteoarthritic activity appears on certain joint surfaces, it can explain the type of activity that the person was participating in while alive. However, recently studies of osteoarthritis have found that it has multifactorial causes (Weiss and Jurmain 2007). Most research had been focused on repetitive mechanical loading and age as factors, but clinical research has shown that other factors are involved. This modern research has shown that genetics can have an impact on onset and severity of osteoarthritis, and that sex differences in osteoarthritis may have more to do with hormones, body size, and anatomy rather than differential activities (Weiss and Jurmain 2007:439). Mechanical stress was found to be linked to mechanical stress if it was high in frequency and

began early in life. However, it is important to note that the effects will not be exemplified in all joints or in all populations (Weiss and Jurmain 2007:444). So while this research will discuss osteoarthritis, it is difficult to attribute this solely to the activity levels of the Algonkians.

Trauma

Trauma can affect the skeleton in four ways: (1) partial or complete breakage in a bone, (2) an unusual displacement or dislocation of joints, (3) a disruption in nerve and/or blood supply, and (4) an artificially induced abnormal shape or contour of a bone (Ortner 2003:119). There can also be multiple causes of trauma in the skeletal remains, including accidental or intentional violence, cultural cosmetic or therapeutic practices that affect bone, and pathological circumstances that may increase the vulnerability of bone to biomechanical stress (Ortner 2003:119).

This study seeks to contribute to the knowledge of health and nutrition at not only West, but the outer coastal region of North Carolina during the Late Woodland. The presence or absence of these pathologies will provide insight into the Late Woodland population at West as well as the wider Outer Coast region of North Carolina.

Previous Research on Outer and Inner Coastal Late Woodland Populations

Dale Hutchinson (2002) conducted a study of four outer coastal and four inner coastal burials dating to the Late Woodland in North Carolina. He was interested in exploring and comparing the health of these populations in regards to their environment and subsistence strategies. Hutchinson had four major hypotheses in his investigation: (1) that the inner coast populations would have a dietary pattern reflecting the use of mostly freshwater estuarine and riverine fauna and maize while the outer coast would reflect a mix of freshwater estuarine and Atlantic flora and fauna with little or no maize; (2) the Late Woodland coastal populations would exhibit pathological lesion frequencies often associated with high maize consumption including carious lesions, hyperostosis, and enamel hypoplasias; (3) the inner and outer coastal groups would display the specific biological effects from their foraging strategies including dental chipping, external auditory exostoses, osteoarthritis, and proliferative responses (periostitis and osteomyelitis); and (4) men and women would exhibit different pathological lesion frequencies and dietary signatures (2002: 15-16).

Hutchinson's comparative study demonstrated important differences between inner and outer coastal populations in behavior and biology. During the Late Woodland, freshwater fish and a C_4 plant, most likely maize, dominated the diet within the Inner Coast region. The Outer Coast consumed a diet of marine fish and little or no maize, with much more variation in food and inclusions (i.e. sand, grit) in their food (Hutchinson 2002:152). Hutchinson correctly hypothesized that inner and outer coastal groups would differ in terms of their dietary focus. Hutchinson also correctly hypothesized that there would be pathological lesion frequencies associated with frequent maize consumption. A maize-focused diet is not one that is particularly nutritious. Corn is high in sugar and deficient or lacking in calcium and in three essential amino acids (lysine, tryptophan, and isoleucine). In addition, niacin (vitamin B_3) in corn is chemically

bound, which prevents bioavailability and it also contains phytate, a chemical that prevents iron absorption (Larsen et al. 2002:411). The outer coastal groups exhibited statistically significant higher frequencies of carious lesions, porotic hyperostosis, and alveolar infections typically associated with a maize diet, despite stable isotope analysis that indicated limited maize consumption (Hutchinson 2002:150). Hutchinson had expected outer coastal groups would have unique pathological lesion frequencies that reflected their foraging strategies. However, Hutchinson found that external auditory exostoses were much lower than expected from previous studies.

Finally, Hutchinson found important differences in osteoarthritis and dental pathology in males and females. Vertebral osteoarthritis was more frequent in outer coastal males than females. Males also had higher frequencies of carious lesions and dental chipping. The location of the chipping on anterior and posterior teeth suggests that it was caused by inclusions with the food, such as sand or gravel (Hutchinson 2002:152). The differences found in males and females suggest that they participated in differential physical labor. The higher rates found in males suggests that they carried out greater physical activity that impacted the spine (Hutchinson 2002:162). The fact that outer coastal males had higher frequencies of dental caries could be because of the higher number of dental chipping found in males (both of the Inner and Outer Coasts) than females. The dental chipping found most frequently in the anterior and posterior teeth suggests that this chipping was due to dietary inclusions, particularly in males.

Proliferative responses, both periosteal and endosteal, are most often caused by treponemal infection in these populations, which was found in higher numbers in the outer coastal populations. It is possible that these are the result of either yaws or endemic syphilis, as demonstrated by studies of prehistoric populations of the Georgia Bight and La Florida

(discussed below). Nasal remodeling is typical of yaws, and it was also observed in several North Carolina individuals (Hutchinson 2002:161).

Georgia Bight and La Florida show some similar patterns compared to those found by Hutchinson in the coastal groups of North Carolina. While the primary purpose of this research is to better understand overall health of outer coastal North Carolina during the Late Woodland, it is also important to understand how unique or similar this small region is to the wider southeast. The next section is a brief overview of similar studies conducted and the results of the Georgia Bight and La Florida.

Georgia Bight and La Florida

In order to understand the West site individuals' experiences as residents of the Outer Coast, these results will be compared to two other Late Woodland outer coastal regions, the Georgia Bight and La Florida. The Georgia Bight was a large embayment that extends from Cape Hatteras, North Carolina to Cape Canaveral, Florida. Clark Larsen conducted similar studies of 17th century Santa Catalina de Guale mission, located on St. Catherine's Island, Georgia of the historic La Florida region.

Georgia Bight

Clark Larsen conducted a bioarchaeological study of the A.D. 1150-1550 native settlements of the Georgia Bight (2000:74). During this period, there was an overall increase in settlement size and density (Larsen and Harn 1994:222). Similar to northern coastal North

Carolina, the settlement changes are associated with loss of mobility and an increasing reliance on agriculture for coastal sites. Also, during these later prehistoric periods there was growing complexity in burial practices, exemplified by the use of burial mounds. Hundreds of skeletons (n = 1413 individuals) spanning the transition from foraging to farming from this area were studied to reconstruct the dietary patterns and related health consequences in these prehistoric populations. Carbon and nitrogen isotopic results showed that early prehistoric coastal foragers of the Georgia Bight had higher carbon and nitrogen isotope ratio values than the contemporary terrestrial foragers from the mainland. Similar to Hutchinson's study of North Carolina's Late Woodland Outer Coast, these isotopic findings suggest that there was a distinct shift to a corn diet in the late prehistoric in the coastal groups; however, unlike North Carolina's Outer Coast population, they were still maintaining the same level of marine food consumption (Larsen et al. 2002).

In order to document health and nutrition-related changes with increased maize agriculture, Larsen and Hutchinson analyzed dental hypoplasias, porotic hyperostosis, cribra orbitalia, dental caries, bone infections, mortality, and biomechanical stress in the Georgia Bight sample. A relatively lower frequency of dental enamel hypoplasias in the farmers compared to the coastal foragers suggests that nutritional stress may have actually declined due to the shift from foraging to farming. Unlike Hutchinson's findings in the study of outer coastal groups in North Carolina, the study of the skulls from both foraging and farming prehistoric populations of the Georgia Bight showed that there was a low frequency of pathological lesions (porotic hyperostosis or cribra orbitalia) associated with iron deficiency. These findings suggest that iron deficiency may not necessarily be linked to diet, specifically the switch to more dependency on corn in the Georgia Bight groups (2000:82). However, similar to Hutchinson's results, dental

caries were substantially more frequent in the farming population than in the foraging groups. This supports the notion that caries became more frequent with dependence on agriculture and a higher consumption of corn (2000:83). Additionally, a comparison of males to females found that males had less carious lesions than females, which suggest that men were consuming less corn than women, a finding that is the opposite of Hutchinson's North Carolina study. Similar to Hutchinson's study, periosteal reactions increased in frequency in all long bone types in the Georgia coastal setting. The overall increase in periosteal reactions is most likely due to a general decline in health as the populations became larger, more sedentary, and more aggregated in permanent or semi-permanent settlements. Finally, an evaluation of osteoarthritis in key joint areas was assessed to understand the change in physical activity and stress between foraging and farming populations. Overall, there was a significant decrease in osteoarthritis in most joints with farming (Larsen et al 2002:426), contrary to the increase in other pathological lesions. However, overall Larsen's findings, like those of Hutchinson's, suggest that the quality of life declined in during the transition from foragers to farmers.

La Florida

Clark Larsen (1990) also conducted a study of skeletal remains from southeastern U.S. mission sites to gain a more comprehensive understanding of health La Florida at the time of European contact. He conducted excavation and study of a large skeletal sample from 17th century Santa Catalina de Guale mission, located on St. Catherine's Island, Georgia (Larsen 1990). The sample represented the remains of the Guale population, the tribe primarily living on the Georgia coast. Larsen discovered that: (1) stable isotope analyses of carbon and nitrogen showed a simultaneous increase in maize consumption and a decrease in seafood diet with time;

(2) enamel defects causes by growth disruption revealed an increase in physiological stress with the arrival of the Europeans; and (3) analyses of limb bone structure indicated an increase in workload, most likely due to labor exploitation by the Spanish (Larsen1990:25).

Similar to the findings of the Georgia Bight and the North Carolina inner coastal population, stable isotope analyses conducted on the mission tribal groups across the region indicated a general pattern either of intensification of maize agriculture or a shift from predominately C_3 foods to maize agriculture (Larsen et al. 1990:68). However, unlike the other two regions, evidence of horticulture and agriculture is scant until European colonization. In general there were less positive stable nitrogen isotope ratios which indicate reduced marine food consumption as seen in the Georgia Bight. This differs from Hutchinson's stable isotope results of the outer coastal sites which indicated a variable diet. In the study of the long bone structures both males and females displayed an increase in osteoarthritic activity in the lower limbs indicating mechanical loading frequently using the lower legs (Ruff and Larsen 1990:137). While males displayed higher rates of osteoarthritis in the upper limbs, females displayed little evidence of upper limb osteoarthritic activity. These biological manifestations indicate both a change in physical activity for both sexes, as well as a division of labor. The study that Hutchinson conducted of the inner and outer coastal groups of North Carolina shows osteoarthritic activity, but it was more prominent in the vertebral column. This difference suggests that these regions were implementing different subsistence strategies that impacted different joint areas.

The analyses of dental enamel hypoplasias in the Florida populations were compared to the findings in the Georgia Bight. Two of the observations made were: (1) the frequency of enamel defects (percent of affected individuals) was greater in the Georgia groups; and (2) in the

Georgia populations the width of hypoplasias was highest for the late prehistoric and early mission period, while in the Florida population the width was greatest in the late prehistoric (Hutchinson and Larsen 1990:194). This implies that even though one regional group was more greatly impacted by early childhood nutritional stress, there is a correlation evident between the later prehistoric periods and an increase in dental enamel hypoplasias consistent in not only La Florida and the Georgia Bight, but the coastal groups of North Carolina as well.

Similar to the results of Late Woodland outer coastal North Carolina, porotic hyperostosis and cribra orbitalia showed a significant increase in frequency during the mission period in Florida. The most significant frequency increase occurred in juveniles (Schultz et al. 1990:208). This frequency increase is a result of a combination of both dietary and living circumstances changes (Schultz et al. 1990:208). As already discussed, there was a shift to a more maize based diet from a predominantly marine food base.

The studies conducted at Georgia Bight and in La Florida (with the European arrival) on coastal and mainland populations have both exemplified an overall deterioration in health. In both regions there is a shift seen in subsistence strategies from a predominately marine food source diet to maize through stable isotopic analysis. There were multiple macroscopic observations made in the skeletons that lend further evidence to a decline in health with this dietary change. These included an increase in dental enamel hypoplasias and anemia indicative of nutritional stress likely associated with the transition to agriculture. Dental health also declined with the maize diet evidenced by an increase in dental caries and abscesses in both the Georgia Bight and La Florida. Interestingly, Georgia Bight and La Florida differed in patterns of workload activity, with La Florida agricultural populations showing an increase in joint stress and the Georgia Bight agricultural populations showing little evidence in workload

intensification. This difference could be, as Hutchinson suggested in the study of Inner and Outer Coast North Carolina, because there was a difference in subsistence strategies. As Hutchinson suggested for inner coastal groups, the La Florida populations could have still been utilizing some foraging skills that would increase mechanical stress in specific joints. There were a few significant differences between males and females in terms of health with females showing a higher frequency of dental caries than men in the Georgia Bight, and males and females displaying differences in workload stress in La Florida.

Based on these studies of coastal populations, as well as previous studies conducted at West by Dale Hutchinson, several outcomes are expected in the study of the recently discovered West site burials. First, there should be a general decline in health seen in the burials similar to other sites where maize is becoming the predominant food strategy. This should be evidenced by dental caries, dental enamel hypoplasias, and an increase in porotic hyperostosis and cribra orbitalia. Second, while the Georgia Bight group did not display this, there should be some evidence of degenerative joint disease consistent with what Hutchinson found in the outer coastal groups of North Carolina. Thirdly, while some differences between the sexes were seen, there should not be any significant differences in the health of males and females at West. The next chapter outlines the methods used in this study to identify the pathologies discussed in this chapter.

Chapter 3: Methods

There are many macroscopically-observable pathologies that can provide information about the health of past individuals. As outlined above, the pathologies observed in this study include carious lesions and periodontal disease, dental damage and modification, enamel hypoplasias, porotic hyperostosis, external auditory exostoses, inflammatory responses such as periosteal reactions and osteomyelitis, infectious diseases, degenerative joint disease (osteoarthritis), and trauma. In this study, the age and sex of the skeletal individuals was estimated using *Standards for Data Collection from Human Skeletal Remains* (Buikstra and Ubelaker1994). The methods used to identify the pathological conditions followed guidelines from *Identification of Pathological Conditions in Human Skeletal Remains* (Ortner 2003). The protocol outlined in Buikstra and Ubelaker (1994) were used to score the pathologies identified via Ortner.

Age and Sex Estimation

Adult female and male skeletons differ in both shape and size in any human population (Buikstra and Ubelaker 1994:16). To estimate the sex of skeletal remains, the os coxae and cranial morphology were assessed. The attributes of the subpubic region such as the ventral arc, the subpubic concavity, and the ischiopubic ramus ridge were scored as: blank-unobservable, 1-female, 2-ambiguous, and 3-male (Buikstra and Ubelaker1994:16). . The greater sciatic notch was recorded on a scale of 1-5, with “1” being the most broad (female), and “5” being the most narrow (male) (Buikstra and Ubelaker 1994:18). The preauricular sulcus, which is thought to be more often present in females than in males, was ranked on a scale of 0-4. “0” will be the

absence of the sulcus, “1” being that the sulcus is wide, usually exceeding 0.5 cm, and deep, “2” being it is wide, usually greater than 0.5 cm, but shallow, “3” being it is well defined but narrow, less than 0.5 cm deep, and “4” being it is a narrow, less than 0.5 cm, shallow, and smooth-walled depression (Buikstra and Ubelaker 1994:18). In determining the sexual dimorphism of the skull, five features, the nuchal crest, the mastoid process, supra-orbital margin, supra-orbital ridge/glabella, and the mental eminence, were scored on a scale of 1-5 (1 being gracile, or female and 5 denoting rugose, or male) (Buikstra and Ubleaker 1994:19-20). Once the estimates for the os coxae and skull were recorded separately, each individual was assigned a number 0-5. “0” being undetermined sex, “1” female, “2” probable female”, “3” ambiguous sex, “4” probable male, “5” male (Buikstra and Ubelaker 1994:21).

The primary methods used in this study to estimate adult age focused on assessing age-related changes to the pubic symphysis, the auricular surface of the ilium, and cranial sutures. In addition, methods that were used to estimate subadult age include fusion rates of epiphyses of different skeletal elements, dental eruption rates, the iliac crest of the os coxae, the basioccipital synchondrosis. The fusion rates of the epiphyses as well as of the os coxae and basioccipital synchondrosis, where applicable, were score from 0 to 2 (“0”: open: epiphysis and diaphysis completely separate; no bony union; “1”: partial union; some union has occurred; and “2”: complete union: all visible aspects of the epiphysis are united) (Ubelaker 1989; Steele and Bramblett 1988). Dental inventory was recorded on a scale of 1 to 8 (Buikstra and Ubelaker 1994). These scores were as follows: “1”: Present , but not in occlusion; “2”: Present, development completed, in occlusion; “3”: Missing, with no associated alveolar bone; “4”: Missing, with alveolus resorbing or fully resorbed: premortem loss; “5”: Missing, with no alveolar resorption: postmortem loss; “6”: Missing, congenital absence; “7”: Present, damage

renders measurement impossible, but other observations are recorded; and “8”: Present, but unobservable (e.g. deciduous or permanent tooth in crypt). However, to assess age from the teeth, the Moorrees et al. (1963) method was used. This method involves observing how much of the crown and roots have developed. To assess the pubic symphysis, both the Todd and Suchey-Brooks pubic symphysis scoring systems were used. The key features that were studied were the ridge-and-furrow system, dorsal margin, dorsal platform, ventral rampart, ossific nodules, rim, and delimited extremities (Todd 1921a, 1921b and Brooks and Suchey 1990) with the right and left sides being scored separately. The Todd scoring system has 10 phases (phase 1: age 18-19, phase 2: age 20-21, phase 3: age 22-24, phase 4: age 25-26, phase 5: age 27-30, phase 6: age 30-35, phase 7: age 35-39, phase 8: age 40-45, phase 9: age 45-49, and phase 10: age 50+) each showing progressively more deterioration of the pubic symphyseal surface. The Suchey-Brooks scoring system of deterioration of the symphyseal face has six phases for which suitable standards for either males or females can be applied. Both scoring systems were used to attain a more accurate age assessment. In addition, the auricular surface of the os coxae demonstrates age-related changes that can also be assessed (Lovejoy et al. 1985). There are eight phases that can be assigned in the auricular surface that assess the condition of the apex, superior and inferior demifaces, retroauricular area, billowing, granularity, density, and porosity (Lovejoy et al. 1985). The other major features that were assessed for age determination is cranial suture closure. Cranial sutures usually fuse with increasing age, but there is significant variability in the fusion rates (Masset 1989). The degree of suture closure was recorded for 10 ectocranial, four palatal, and three endocranial locations. The degree of closure for the sutures was designated as one of these five stages: “blank”: unobservable, “0”: open, “1”: minimal closure, “2”: significant closure, and “3”: complete obliteration (Masset 1989).

Carious Lesions and Periodontal Disease

This research used Buikstra and Ubelaker's (1994) scoring system for dental caries. The caries where found, were recorded for each of the 32 permanent teeth and their location on the teeth. The scoring system has eight numbers that can be assigned as follows: "0": no lesion present, "1": occlusal surface, "2": interproximal surfaces, "3": smooth surfaces, "4": cervical caries, "5": root caries, "6": large caries, and "7": noncarious pulp exposure (Buikstra and Ubelaker 1994:55).

In looking at archaeological skulls, the primary manifestation of periodontal disease will be local or general resorption of the alveolar bone and/or the alveolar process (Ortner 2003:593). The presence of calculus in association with resorption of the alveolar bone and lack of caries supports a diagnosis of periodontal disease. Calculus was reported as follows: "0": absent, "1": small amount, "2": moderate amount, "3": large amount, or "9": unobservable (Buikstra and Ubelaker 1994). Furthermore, it would be noted on which side (buccal or lingual) of the tooth that the calculus was present.

Dental Damage and Modification

The format used for scoring damage and wear utilizes only scoring the teeth from the left side of the dental arcade, with substitutions from the right if a left tooth is missing (Buikstra and Ubelaker 1994:52). For the premolars, canines, and incisors, wear was recorded on an eight point

scale, based on the amount of dentin exposed (Murphy 1959 and Smith 1984). Each molar's occlusal surface was divided into four quadrants and the amount of observable enamel was scored on a scale of 1 to 10. The final score recorded for each tooth is the sum for each tooth is the sum of scores of the four quadrants, yielding a possible range of 4 to 40 (Scott 1979). To distinguish antemortem dental damage from postmortem, the rounding of the fracture edges indicative of antemortem wear from chewing was observed.

Dental Enamel Hypoplasias

The observable characteristic of this pathology is the presence of transverse hypoplastic lines. This research used Buikstra and Ubelaker's (1994) listed attributes to assess the presence of hypoplasias. There are six attributes that they list: "0": absence, "1": linear horizontal grooves, "2": linear vertical grooves, "3": linear horizontal pits, "4": nonlinear arrays of pits, and "5": single pits (1994:56). When the enamel hypoplasias were present, measurements were taken between the cemento-enamel junction and the hypoplasia grooves on the tooth with sliding calipers. These measurements were then plugged into a regression equation developed by Goodman and Rose (1990). The formula that provides the age at which the formation of the defect occurred is: age at crown completion subtract (years of formation divided by crown height) multiplied by the defect height from the cemento-enamel junction.

Porotic Hyperostosis

Buikstra and Ubelaker's (1994) assessment for porotic hyperostosis was used in this research. Their methods include the observation of the various degrees of this pathology's expression and location (1994:120-121). Often, porotic hyperostosis occurs on the orbital surface

of the frontal bone or next to the lambdoid, sagittal, or sometimes the coronal sutures. In extreme cases, the frontal, parietal, and occipital bones may be involved in their more central regions (1994:120). The recording system used in this study is from Stuart-Macadam (1985) for the frontal, parietal, and occipital bones. This scoring system distinguishes between “very indistinct porosity”, “true porosity”, “coalescing pores”, and “coalescing pores in association with expansive changes”. If there were varying degrees of expression occurring, the most extreme were recorded.

Periosteal Reactions

Periosteal reactions can take the form of an organized, remodeled subperiosteal hematoma, which can originate from trauma (or scurvy), and is identified by a newly formed spongy bone buildup that is found on the external surface of the bone shaft. This is distinguished by central periosteal bone deposits around an incomplete cortical defect, with or without a small sequestrum, and some sclerotic response in the area (Ortner 2003:181). Most of the abnormal bone formations will be macroscopically visible as either lamellae or vertical spicules added to the intact external surfaces. The structures may be relatively recent additions of woven bone, which would indicate an active process near the time of death. Or, the formations could have been subject to remodeling, which would produce a sclerotic reaction indicative of healing or a chronic disease process (Buikstra and Ubelaker 1994:118). In order to accurately identify the timing and rate, it is important to distinguish lamellae of woven bone from sclerotic additions that have become integrated with the cortex. Reactions that include both woven and sclerotic

bone if present are coded as “mixed”. Additionally, sclerotic activity was recorded by what skeletal element was affected and whether it was still “active” or “healed”.

External Auditory Exostoses

External auditory exostoses manifest themselves in new bone formations along the external auditory canal (Ortner 2003:88). The bony nodule, if present, would develop within the internal auditory meatus. The degree of canal occlusion, if present, was scored as 1/3 to 2/3 occluded or greater.

Specific Infectious Diseases

Diagnosis of specific infectious diseases in skeletal remains is conducted by observing the manifestation of lesion morphology, the pattern of the lesions in the entire body, and the demographic distribution of similar lesions in the population (Hutchinson 2002:76). The information is then compared to modern clinical data in deciding which disease process is most likely responsible. This study followed the four steps used by Hutchinson in determining if infectious disease is present in the skeletal remains: (1) lesions pathognomic for disease, like stellate lesions indicating treponemal infection, (2) the presence of cloacae (openings for pus drainage), indicating osteomyelitis, (3) similar lesions for multiple elements of a single

individual, pointing to a systemic infection, and (4) patterning of lesions across a sample (Hutchinson 2002:119).

Degenerative Joint Disease (Osteoarthritis)

Evidence for osteoarthritis in archaeological remains can occur in subchondral bone, the spongy bone under subchondral bone, and at the margins of subchondral bone. In observing joint surfaces, osteoarthritis can manifest itself as bone destruction and/or bony hypertrophy. Arthritic destruction is expressed as porosity, frequently with eburnation (polishing) of the affected bone surface (Ortner 2003:550). The assessment for the presence of osteoarthritis required the scoring system outlined by Buikstra and Ubelaker (1994) and then organized by joint affected. The scoring system noted the presence and degree of lipping, surface porosity, and eburnation (1994:122-123).

Trauma

There are many different types of trauma that can be identified in skeletal remains. The first is fractures, which is any traumatic event that results in partial or complete discontinuity of a bone (Ortner 2003:120). There are five types of fractures: tension, compression, torsion or twisting, flexion or bending, and shearing. The healing of a fracture will leave a callus of abnormal bone growth over the area that was affected. Dislocation is another major type of trauma that which occurs when there is a disruption in the normal relationship between the bony (and the associated articular cartilage) components of a joint (Ortner 2003:159). The skeletal

evidence for dislocation is the presence of a compression fracture and the formation of a secondary joint. Buikstra and Ubelaker's scoring system (1994:119-120) was used to determine the presence and severity of trauma in West burials four and five. The scoring system noted the bone affected, whether the fracture was "complete", "partial", "simple", "comminuted", "spiral", compression, or "depression", and what stage of healing, if any, the fracture was in at the time of death.

Once the analysis of the West Burials 4 and 5, and the reassessment of burial one were completed using the above mentioned methods, the information was then used to make comparative analyses. The information is intended to contribute to a comparison of these burials to other inner and outer coastal populations. It will also aid in assessing the presence of patterns by pathology, age, and sex in the different burial practices seen. The results of the analyses of Burials 4 and 5 follow as well as the reassessment of Burial 1 and a summary of the relevant data of Burial 2.

Chapter 4: Analysis

Analysis of Burials 4 and 5 and reanalysis of Burial 1was conducted using the methods outlined in the previous chapter. Burials 4 and 5 were brought back to East Carolina University where they were cleaned, sorted, and analyzed. Burial 1 was loaned to East Carolina University for study by the North Carolina Office of State Archaeology, where the remains were also sorted and reanalyzed. What follows are summaries of the data collected on each of these burials. Additionally, the results of the comparative analyses of West and the Outer Coast, and differences between sexes at both West and the wider outer coastal area that were conducted are also incorporated into this chapter.

Burial 4

Burial 4 was a primary burial that contained two individuals. The remains were collected by individual during field recovery then cleaned and analyzed in the laboratory. The two individuals were then scored for sex and age according to the Buikstra and Ubelaker standards outlined in the previous chapter. The results of each observable feature for sex estimation are summarized in Table 4.1. Based on the scores of the pelvis and the skull features, Skeleton 1 is female. The pelvis features of Skeleton 2 that were observed and scored were the left and right ventral arc, the left and right subpubic concavity, the left and right ischiopubic ramus ridge, the left and right greater sciatic notches, and the left and right preauricular sulcus. The skull features that were scored were the nuchal crest, left and right mastoid processes, left and right supraorbital margins, and glabella and mental eminence. The scores of both the pelvis and skull

are listed in Table 4.2. While there were a few ambiguous scores, this individual is likely a male. The age of the female was determined from observations made of features on the pelvis and skull (See Table 4.3). The age of the individual based on the pelvis most likely ranges from 25-34 years. The skull scores suggest an age range of 22-45 years. It seems probable then that the female was approximately between the ages of 25-35 years at time of death. The male's pelvis and skull scores are listed in Table 4.4. Age of this individual based on the pelvis ranges from approximately 25-29 years. The composite scores of the skull provide a vault age range of 23-45 years and a lateral-anterior score range of 28-44 years. It is estimated then that the male's age ranged from early twenties to mid-thirties at time of death.

Table 4.1. Burial 4 Skeleton 1 Sex Estimation.

	Feature	Left	Midline	Right	Estimated Sex
Pelvis	Ventral Arc	1		N/A	1-Female
	Subpubic Concavity	N/A		N/A	
	Ischiopubic Ramus Ridge	1		-	
	Greater Sciatic Notch	1		2	
	Preauricular Sulcus	1		2	
Skull	Nuchal Crest	-	3	-	1-Female
	Mastoid Process	1		1	
	Supraorbital Margin	2		2	
	Glabella	-	1	-	
	Mental Eminence	-	2	-	

Table 4.2. Burial 4 Skeleton 2 Sex Estimation.

	Feature	Left	Midline	Right	Estimated Sex
Pelvis	Ventral Arc	3	-	3	5-Male
	Subpubic Concavity	3	-	3	
	Ischiopubic Ramus Ridge	3	-	3	
	Greater Sciatic Notch	4	-	5	
	Preauricular Sulcus	4	-	4	
Skull	Nuchal Crest	-	5	-	
	Mastoid Process	2	-	3	
	Supraorbital Margin	5	-	4	
	Glabella	-	5	-	
	Mental Eminence	-	5	-	

Table 4.3. Burial 4 Skeleton 1 Age Estimation.

	Feature	Left	Right	Suture Closure	Estimated Age
Pelvis	Todd	4	-	-	25-26
	Suchey-Brooks	3	-	-	21-53
	Auricular Surface	2	3	-	25-34
Cranial Sutures	Midlambdoid	-	-	1	-
	Lambda	-	-	1	-
	Obelion	-	-	1	-
	Anterior Sagittal	-	-	1	-
	Bregma	-	-	1	-
	Midcoronal	-	-	2	30.5 avg.

Table 4.4. Burial 4 Skeleton 2 Age Estimation.

	Feature	Left	Right	Suture Closure	Estimated Age
Pelvis	Todd	N/A	4	-	25-26
	Suchey-Brooks	N/A	3	-	21-53

	Auricular Surface	2	2	-	25-29

Table 4.4. Burial 4 Skeleton 2 Age Estimation (Continued).

	Feature	Left	Right	Suture Closure	Estimated Age
Cranial sutures	Midlambdoid	-	-	1	-
	Lambda	-	-	1	-
	Obelion	-	-	1	-
	Anterior Sagittal	-	-	0	-
	Bregma	-	-	0	30.5 avg.
	Midcoronal	-	-	1	-
	Pterion	-	-	0	-
	Sphenofrontal	-	-	0	-
	Inferior Sphenotemporal	-	-	0	-
	Superior Sphenotemporal	-	-	1	30.5 avg.

Dental caries were found in both skeletons' dentitions. The female had four interproximal surface caries on her maxillary right M^1, P^2, I^2, and maxillary left I^2. She also had an occlusal surface caries on right mandibular M_3. The male had an occlusal surface caries on the maxillary right M^1, cervical caries on the mandibular left M_2 and mandibular right M_2, and large caries on the mandibular left M_1 and mandibular right M_1. The male had an abscess on the buccal channel beneath the mandibular left M_1. There was also a supernumerary tooth, a congenital anomaly, noted in the male between the maxillary right P^1 and P^2 that can be described as a root and no crown (Figure 4.1).

Figure 4.1. Burial 4 Male's Supernumerary Tooth between the Maxillary Right P^1 and P^2

Both individuals had multiple enamel hypoplasias. The female individual had a high frequency of enamel hypoplasias. She exhibited three types: (1) linear horizontal grooves (most common), (2) linear horizontal pits, and (3) linear vertical grooves (one occurrence). Nutritional stress occurred for the female between the ages of 3-6 years. The male also had a high frequency of enamel hypoplasias. He exhibited both linear horizontal grooves and linear horizontal pits. The male exhibited nutritional stress at approximately the ages of 1.5-5 years.

Other pathologies were recorded in both individuals of Burial 4 (See Tables 4.5 and 4.6 for detailed observations). The female exhibited healing porotic hyperostosis on both sides of the frontal bone within the upper orbits (Figure 4.2). The female also exhibited partial spina bifida in the sacrum (Figure 4.3). Arthritis was also recorded in both the left and right humerii. The left humerus exhibited moderate arthritic activity at the shoulder. The right humerus also displayed

mild lipping at the shoulder. She also displayed moderate arthritic activity at the elbow on the right humerus. The male individual displayed mild degeneration on the lower part of the left fibula, at the ankle joint (See Table 4.6). This individual also displayed arthritis on the 4th and 5th lumbar vertebrae. The male had other multiple instances of arthritis. There was a display of mild activity at the shoulder of the left humerus and the left glenoid fossa of the shoulder blade. Mild arthritic activity was recorded on both the right and left ulnas at the elbow joints. Moderate activity was noted in the right and left radii at the wrist joints. The left first metacarpal exhibited severe arthritis at the end of the finger joint (i.e. the knuckle). Both the right and left acetabulum displayed moderate arthritis at the hip. Moderate arthritic activity was noted on the left femur at the knee joint. There was also mild arthritis noted on the left tibia at the same joint.

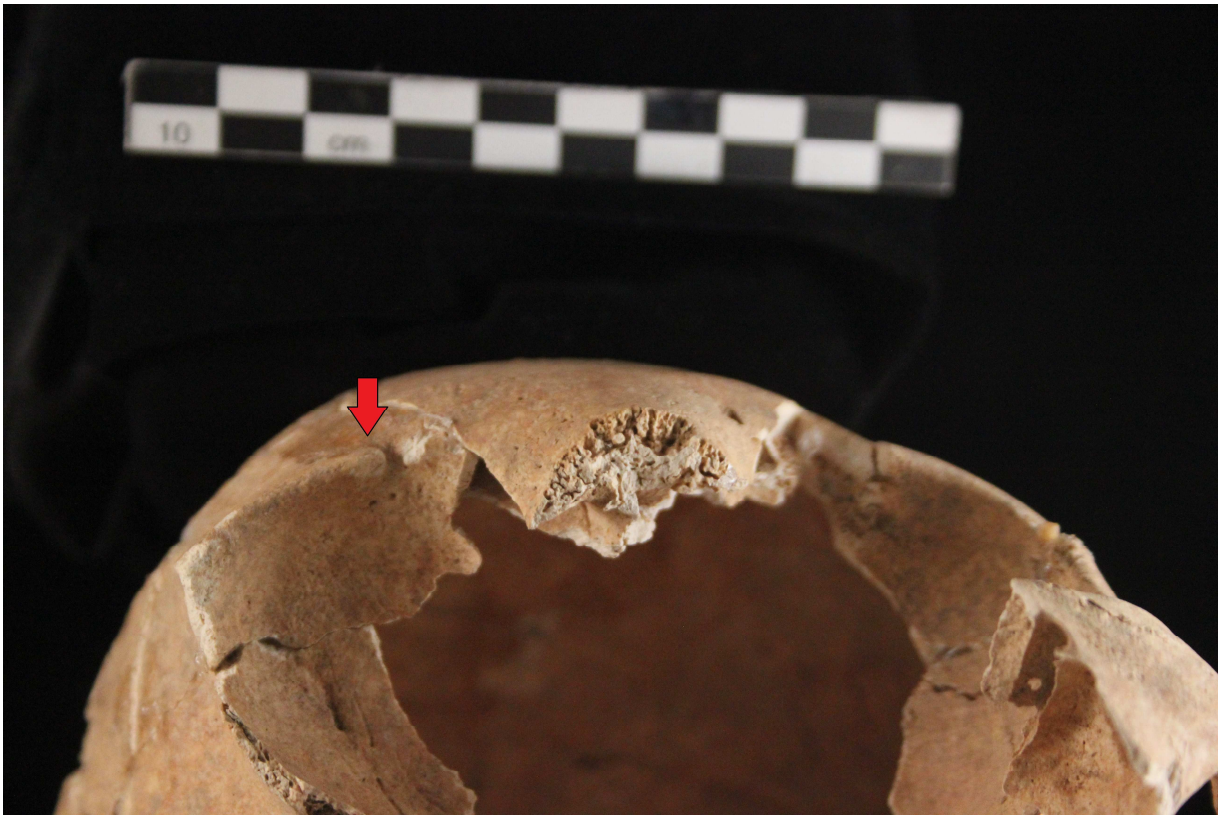

Figure 4.2. Burial 4 Female's Healed Porotic Hyperostosis in the Right Eye Orbit

Figure 4.3. Burial 4 Female's Partial Spina Bifida

Table 4.5. Burial 4 Skeleton 1 Pathologies.

Bone	Side	Pathology	Observation 1	Observation 2
Frontal	Left	Porotic Hyperostosis	Coalescing foramina with increased thickness in the eye orbits; exhibited healing	-
Frontal	Right	Porotic Hyperostosis	Barely discernible in the eye orbits; exhibited considerable healing	-

Table 4.5 Burial 4 Skeleton 1 Pathologies (Continued).

Bone	Side	Pathology	Observation 1	Observation 2
Sacrum		Spina bifida	Partial spina bifida	-
Humerus	Left	Arthritis	Sharp ridge with less than 1/3 lipping on the posterior surface of the proximal articular surface	-
Humerus	Right	Arthritis	Less than 1/3 lipping that was barely discernible on the posterior surface of the proximal articular surface	Less than 1/3 lipping with a sharp ridge on the anterior distal articular surface

Table 4.6. Burial 4 Skeleton 2 Pathologies.

Bone	Side	Pathology	Observation
Fibula	Left	Sclerotic Reaction	Occurring on less than 1/3 along the medial aspect of the distal 1/3 of the diaphysis
4th Lumbar vertebra	-	Osteophytes	Curved spicules occur on both the inferior and superior surfaces of the vertebral bodies
5th Lumbar vertebra	-	Osteophytes	Curved spicules occur on both the inferior and superior surfaces of the vertebral bodies
Humerus	Left	Arthritis	Barely discernible lipping extending less than 1/3 of the posterior surface on the proximal epiphysis
Scapula	Left	Arthritis	Barely discernible lipping occurs on less than 1/3 of the inferior surface of the glenoid fossa
Ulna	Right	Arthritis	Barely discernible lipping occurs less than 1/3 extending circumferentially on the proximal articular surface
Ulna	Left	Arthritis	Barely discernible lipping occurs less than 1/3 extending circumferentially on the proximal articular surface
Radius	Right	Arthritis	Sharp ridges found on 1/3-2/3 extent of the posterior distal articular surface
Radius	Left	Arthritis	Sharp ridges found on 1/3-2/3 extent of the posterior distal articular surface
1st	Left	Arthritis	Sharp ridges found on 1/3-2/3 extent of the dorsal aspect

Metacarpal			of the distal articular surface
Os Coxa	Right	Arthritis	Sharp ridges found on less than 1/3 extent of the posterior articular surface of the acetabulum
Os Coxa	Left	Arthritis	Sharp ridges found on less than 1/3 extent of the posterior articular surface of the acetabulum
Femur	Left	Arthritis	Sharp ridges found on less than 1/3 extent of the posterior distal articular surface
Tibia	Left	Arthritis	Barely discernible lipping visible on the anterior proximal articular surface

Burial 5

Burial 5 was a primary burial that contained one individual. Sex and age were determined from the features that were observable (See Table 4.7 for sex estimation scores). Only the left greater sciatic notch of the pelvis was observable for sex estimation, which was given a "3" (ambiguous). However, on the skull multiple features were observable and scored. From the skull, it was determined that this individual was female. Age was more difficult to determine because so little of the pelvis was present, and the sutures were mostly unobservable. The left auricular surface was rated as "1", which gives an age range of 20-24. However, it was evident that many skeletal elements had partial union of proximal and distal epiphyses, as well as partial union of the iliac crest and ischial tuberosity (See Table 4.8). Based on the epiphyseal union rates, this individual must have been between the ages of 14-19 years at time of death. While conducting the dental inventory, it was observed that three of the third molars were present, but not in occlusion (i.e., fully erupted) (Table 4.9). Based on the dental eruption rates the age of this individual was 15 years ± 36 months, which is consistent with the epiphyseal union rates.

Table 4.7. Burial 5 Sex Estimation.

	Feature	Left	Midline	Right	Estimated Sex
	Ventral Arc	N/A	-	N/A	

Pelvis	Subpubic Concavity	N/A	-	N/A	3-Ambiguous
	Ischiopubic Ramus Ridge	N/A	-	N/A	
	Greater Sciatic Notch	3	-	N/A	
	Preauricular Sulcus	N/A	-	N/A	

Table 4.7. Burial 5 Sex Estimation (Continued).

	Feature	Left	Midline	Right	Sex
Skull	Nuchal Crest	-	1	-	1-Female
	Mastoid Process	1	-	1	
	Supraorbital Margin	2	-	3	
	Glabella	-	1	-	
	Mental Eminence	-	N/A	-	

Table 4.8. Burial 5 Age Estimation Based on Epiphyseal Union Rates.

Bone	Epiphysis	Area of Union	Stage of Union	Age Estimation
2nd Cervical Vertebrae	superior		Complete	≥15 years
2nd Cervical Vertebrae	inferior		Partial	14-21 years
Thoracic Vertebrae	superior		Partial	14-27 years
Thoracic Vertebrae	inferior		Partial	14-27 years
Left Humerus	distal		Complete	9-13 years
Right Humerus	distal		Complete	9-13 years
Left Humerus	medial epicondyle		Partial	10-15 years
Right Humerus	medial epicondyle		Partial	10-15 years
Left Radius	proximal		Complete	14-19 years
Right Radius	distal		Partial	16-22 years
Left Os Coxae	iliac crest		Partial	14-22 years
Left Os Coxae	ischial tuberosity		Partial	16-20 years
Left Femur	Head		Partial	15-19 years
Right Femur	Head		Partial	15-19 years
Left Femur	greater trochanter		Complete	13-17 years
Right Femur	greater trochanter		Complete	13-17 years

Table 4.8. Burial 5 Age Estimation Based on Epiphyseal Union Rates (Continued).

Bone	Epiphysis	Area of Union	Stage of Union	Age Estimation
Left Femur	lesser trochanter		Complete	13-17 years
Right Femur	lesser trochanter		Complete	13-17 years
Left Femur	Distal		Partial	14-17 years
Right Femur	Distal		Partial	14-17 years
Left Tibia	Proximal		Partial	14-17 years
Right Tibia	Proximal		Partial	14-17 years
Left Tibia	Distal		Partial	14-16 years
Right Tibia	Distal		Partial	14-16 years
Left Fibula	Distal		Partial	13-16 years
Sacral Segments		1-2	Complete	17+ years
Sacral Segments		2-3	Complete	16-25 tears
Cervical Vertebrae		neural arches to eachother	Complete	≥4 years
Cervical Vertebrae		neural arches to centrum	Complete	≥7 years
Thoracic Vertebrae		neural arches to eachother	Complete	≥4 years
Thoracic Vertebrae		neural arches to centrum	Complete	≥7 years

Table 4.9. Burial Age Estimation Based on Dental Development.

Skeletal Feature	Age Indicator	Development	Age Estimation
Right M^3	13	the root apex was ½ closed	
Left M^3	14	the root apex was closed	
Left M_3	12	the root length was complete	15 years ± 36 months

The individual did have a few dental caries that were observed and recorded. The maxillary right and left first incisors had interproximal surface caries. An occlusal surface caries was also found on the mandibular right M_1.

This female did have a high frequency of enamel hypoplasias. The majority of hypoplasias were manifested in linear horizontal grooves. However, there were also a few occurrences of linear horizontal pits, and one occurrence each of nonlinear arrays of pits and single pits. Physiological stress resulting in these defects occurred between the ages of 2-6 years.

Interestingly, there were no other pathologies observed in this female individual. However, one observation made was that many of the bones were very light in weight, which could be indicative of osteoporosis.

Burial 1

Burial 1 was a commingled burial that was excavated in 1984 and was subsequently analyzed by McCall and Griffin 1985. They concluded that there were five adult males and one possible female ranging in age from late teens to 35 years. A reanalysis by this author in 2010 found that this burial actually includes at least eight individuals: six adults, one child, and one subadult.

Sex estimation of the adults was difficult to determine from the skull and pelvis fragments (See Table 4.10). A skull labeled “2” (consisting of parietals, occipital, and right temporal), was scored as a probable female. A skull labeled “4” (consisting of the occipital) was

identified as female. A skull labeled “1” (consisting of parietals, temporals, and occipital) was also identified as a probable female. Skull “3” (consisting of a frontal) was identified as probable female. Skull “6” (consisting of a temporal) was identified as a female. There was one other skull of indeterminate sex. In addition two os coxae fragments were observed to estimate sex. A left os coxa fragment (labeled #2) and right os coxa fragments (labeled #1) were scored as female.

The cranial suture closure stage of the skulls also was observed for age estimation. Only three of the skulls were able to be given age estimates. Skull “#2”, the probable female, was given a vault composite score suggesting an age range of 22-45 years (See Table 4.11). Skull “#4”, female, was given a vault composite score indicating the same age range. Skull “#1”, probable female, was given an estimated age range of 28-44 years. Therefore, in terms of the adult in the sample, three of these individuals ranged in age between 22 and 45 years.

Twenty deciduous teeth presumably from the subadult were inventoried and scored in terms of development. They appeared to be from one individual aged 6-10 months of age. There was also a clavicle that was scored for epiphyseal closure. This left clavicle was scored “0” for open on its sternal end, which indicates that the individual had to be less than 17 years. In total there was one subadult (birth to three years of age), and one child (three to twelve years of age) of indeterminate sex.

Table 4.10. Burial 1 Sex Estimations.

Skeleton	Feature	Left	Midline	Right	Estimated Sex
Skull Labeled #1	Nuchal Crest	-	1	-	Probable Female
	Mastoid Process	3	-	2	
	Supraorbital Margin	N/A	-	N/A	

Skull Labeled #2	Glabella	-	N/A	-	Probable Female
	Mental Eminence	-	N/A	-	
	Nuchal Crest	-	2	-	
	Mastoid Process	N/A	-	2	
	Supraorbital Margin	N/A	-	N/A	
Skull 3	Glabella	-	N/A	-	Probable Female
	Mental Eminence	-	N/A	-	
	Nuchal Crest	-	N/A	-	
	Mastoid Process	N/A	-	N/A	
	Supraorbital Margin	N/A	-	2	

Table 4.10. Burial 1 Sex Estimations (Continued).

Skeleton	Feature	Left	Midline	Right	Estimated Sex
Skull Labeled #4	Nuchal Crest	-	1	-	Female
	Mastoid Process	N/A	-	N/A	
	Supraorbital Margin	N/A	-	N/A	
	Glabella	-	N/A	-	
	Mental Eminence	-	N/A	-	
Skull 5	Nuchal Crest	-	N/A	-	Ambiguous
	Mastoid Process	N/A	-	N/A	
	Supraorbital Margin	N/A	-	3	
	Glabella	-	N/A	-	
	Mental Eminence	-	N/A	-	
Skull 6	Nuchal Crest	-	N/A	-	Female
	Mastoid Process	1	-	N/A	
	Supraorbital Margin	N/A	-	N/A	
	Glabella	-	N/A	-	
	Mental Eminence	-	N/A	-	

Table 4.10. Burial 1 Sex Estimations (Continued).

Skeleton	Feature	Left	Right	Estimated Sex
Os Coxa Labeled #1	Ventral Arc	N/A	N/A	Female
	Subpubic Concavity	N/A	N/A	
	Ischiopubic Ramus Ridge	N/A	N/A	
	Greater Sciatic Notch	N/A	1	
	Preauricular Sulcus	N/A	N/A	
Os Coxa Labeled #2	Ventral Arc	N/A	N/A	Female
	Subpubic Concavity	N/A	N/A	
	Ischiopubic Ramus Ridge	N/A	N/A	
	Greater Sciatic Notch	1	N/A	
	Preauricular Sulcus	N/A	N/A	

Table 4.11. Burial 1 Age Estimations.

Skeleton	Feature	Suture Closure	Estimated Age
Skull Labelled #1	Lambda	3	28-44 years
	Obelion	3	
	Anterior Sagittal	3	
	Bregma	N/A	
	Midcoronal	N/A	
	Pterion	N/A	
	Sphenofrontal	N/A	
	Inferior Sphenotemporal	N/A	
	Superior Sphenotemporal	N/A	
	Incisive	N/A	
	Anterior Median Palatine	N/A	
	Posterior Median Palatine	N/A	
	Transverse Palatine	N/A	
	Sagittal	3	
Skull Labeled #2	Midlambdoid	2	22-45
	Lambda	2	
	Obelion	2	
	Anterior Sagittal	2	
	Bregma	N/A	
	Midcoronal	N/A	
	Pterion	N/A	
	Sphenofrontal	N/A	
	Inferior Sphenotemporal	N/A	
	Superior Sphenotemporal	N/A	
	Incisive	N/A	
	Anterior Median Palatine	N/A	
	Posterior Median Palatine	N/A	
	Transverse Palatine	N/A	
	Sagittal	3	
	Left Lambdoid	3	
	Left Coronal	N/A	

Table 4.11. Burial 1 Age Estimations (Continued).

Skeleton	Feature	Suture Closure	Estimated Age
	Left Lambdoid	3	
	Left Coronal	N/A	
Skull Labeled #4	Midlambdoid	N/A	
	Lambda	2	
	Obelion	2	
	Anterior Sagittal	2	22-45
	Bregma	N/A	
	Midcoronal	N/A	
	Pterion	N/A	
	Sphenofrontal	N/A	
	Inferior Sphenotemporal	N/A	
	Superior Sphenotemporal	N/A	
	Incisive	N/A	
	Anterior Median Palatine	N/A	
	Posterior Median Palatine	N/A	
	Transverse Palatine	N/A	
	Sagittal	3	
	Left Lambdoid	N/A	
	Left Coronal	N/A	

Dental caries and a few abscesses were observed in the teeth recovered from the commingled burial. An occlusal surface caries was observed on the maxillary left P^3, and an interproximal surface caries was recorded on a mandibular right M_3. Abscesses were recorded on both left and right mandible fragments on the buccal side.

Dental defects in the form of different types of hypoplasias were recorded on multiple teeth. The most frequently recorded were linear horizontal grooves. However, there included a

few instances of linear horizontal pits and nonlinear horizontal pits. Of the recovered dentition, nutritional stress occurred at least three times between the ages of ca. 1 to 6 years.

Multiple pathologies were recorded in the commingled skeletons (See Table 4.12). Sclerotic activity in the form of myositis ossificans was observed along the linea aspera of a left femur, extending more than 2/3 around both the proximal and distal articular surfaces. A left fibula exhibited a narrowed medullary cavity with cancellous bone expansion that extended more than 2/3 around the middle portion of the shaft with no visible lamellae. On a right fibula there is evidence of mild woven and sclerotic reaction along the proximal 1/3 of the shaft. Mild sclerotic reaction was also noted on the proximal 1/3 of the shaft of an unsided tibia. A right tibia exhibited severe cancellous expansion around the distal portion of the shaft. Another unsided tibia displayed moderate woven and sclerotic reaction along the proximal portion of the shaft. Finally, a left tibia exhibited severe woven and sclerotic reaction with cancellous expansion and trabecular coarsening all along the shaft.

Table 4.12. Burial 1 Pathologies.

Bone	Side	Pathology	Observation
Femur	Left	Sclerotic Activity	Myositis ossificans along the linea aspera extending more than 2/3 around both the proximal and distal articular surfaces of a left femur
Fibula	Left	Sclerotic Activity	Medullary cavity narrowed with no visible lamellae and cancellous expansion extending more than 2/3 around the middle of the diaphysis
Fibula	Right	Sclerotic Activity	Both woven and sclerotic reaction expanding less than a third around the proximal portion of the diaphysis
Tibia	Unsided	Sclerotic Activity	Reaction was noted on less than 1/3 of the proximal 1/3 diaphysis
Tibia	Right	Sclerotic Activity and Cancellous Expansion	Exhibited all around cancellous expansion that extended over more than 2/3 of the distal portion of the diaphysis

Tibia	Unsided	Sclerotic Activity	Displayed both woven and sclerotic reaction extending 1/3-2/3 around the proximal portion of the diaphysis
Tibia	Left	Sclerotic Activity	Exhibited both woven and sclerotic reaction with cancellous expansion and trabecular coarsening extending more than 2/3 around the total diaphysis

Burial 2

Burial 2 was analyzed by Dale Hutchinson after excavations of this ossuary in 1994. Thirteen discrete areas of remains (bundles) were recorded by Mark Mathis, the excavator. This large burial has an MNI of 135. The age breakdown is listed in Table 4.13. The study was only able to identify the sex of 27 individuals due to the commingling of remains, 16 females and 11 males.

Table 4.13. Burial 2 Age Ranges.

Age Ranges	Number of Individuals
0 to 2 years	4
3 to 4 years	10
5 to 9 years	7
10 to 14 years	2
15 to 19 years	5
20 to 29 years	2
30 to 39 years	1
40 to 49 years	3
50+ years	1
Subadult of indeterminate age	30
Adults of indeterminate age	70

Hutchinson recorded multiple pathologies in these burials. Twelve percent of the skeletal remains displayed carious lesions and10% displayed alveolar infections. Porotic hyperostosis

was evident in 30% of the individuals. Of these, there were two parietals that displayed possible stellate lesions indicative of infectious disease. Only two tibias displayed periosteal reactions; however another 11 unidentified long bone fragments also exhibited periosteal reactions. Nine percent of the vertebrae displayed osteophytic lipping. Of these, seven vertebrae also displayed degenerative joint disease, and two exhibited Schmorl's nodes. It is also worth noting that one tibia, fibula, and rib exhibited osteoporosis. There were also a few occurrences of trauma: one frontal bone exhibited healed blunt force trauma, there were two thoracic vertebrae (T11 and T12) that exhibited compression fractures, two ulnae exhibited healed fractures, and a clavicle exhibited periostosis, plaquing, and had a cloaca for infection draining likely attributable to trauma. There was also one instance of treponematosis in a frontal bone, indicative of an infectious disease such as syphilis or yaws.

Enamel defects such as enamel hypoplasias were recorded and were incorporated into a larger study by Hutchinson comparing nutritional statuses of inner versus outer coastal Late Woodland sites. For a summary of the pathology frequencies found in the West burials, see Table 4.14 below.

Table 4.14. Pathology Frequencies of West Burials and Other Late Woodland North Carolina Outer Coastal Sites (West 2 and comparative data from Hutchinson 2002).

Pathology	West 1	West 2	West 4	West 5	Outer Coastal Sites
	% / n	% / n	% / n	% / n	% / n
Carious Lesions (% of adult teeth)	5% / 38	12% / 151	16% / 64	9% / 32	19% / 2369
Abscesses (% of associated adult teeth)	5% / 38	10% / 151	2% / 64	0% / 32	32% / 2369
Enamel Hypoplasias (% of adult teeth)	34% / 38	N/A	38% /64	66% / 32	9% / 2369
Periosteal Reactions (% of long bones)	33% / 21	19% / 68	8% / 12	0% / 6	11% / 1136
Porotic Hyperostosis (% of cranial vault bones)	0% / 23	30% / 122	25% / 4	0% / 4	36% / 437
External Auditory Exostoses (% of individuals)	0% / 8	0% / 135	0% / 2	0% / 1	4% / 186

Overall Health within the Late Woodland West Site

Dental Caries

In Hutchinson's study of dental caries of the outer coastal Late Woodland sites, he observed a high frequency of this pathology in individuals from these sites (n=450; 19%) (Hutchinson 2002). Carious lesions were noted in every burial from West. However, a Chi Square test comparing the frequencies of this indicator in the West Burials to the outer coastal Late Woodland populations found a statistically significant difference (χ=85.39; $p < 0.0001$).

Dental Enamel Hypoplasias

Hutchinson's analysis of enamel hypoplasias consisted of a sample of 196 dentitions of adults from Outer Coast sites. In total, Hutchinson only observed hypoplasias in 12 adults from the Outer Coast (Hutchinson 2002). There appears to be no significant difference in frequency between West and other outer coastal sites (χ=1.96; p=0.16).

External Auditory Exostoses

Hutchinson analyzed 186 outer coastal individuals for external auditory exostoses. In his study he found only one male from Baum, and six individuals of indeterminate sex from the same site exhibiting exostoses (Hutchinson 2002). There was no significant difference found when West was compared to the Outer Coast individuals (χ=2.80; p=0.22).

Porotic Hyperostosis

Porotic hyperostosis lesions are common in outer coastal sites. In the majority of adults and subadults, these lesions were in the process of healing. In Hutchinson's research he found that outer coastal adults exhibited much higher frequencies (36%) than subadults (9%) (2002:97). At West in Burial 2, Hutchinson recorded 30% of 122 cranial bones exhibiting hyperostosis lesions, most in the process of healing. In the recent study of the other burials, only Burial 4 exhibited porotic hyperostosis in one individual, the female. There was no significant difference found between West and the other outer coastal sites (χ=3.30; p=0.85).

Infectious Disease

Infectious disease was noted in two forms in outer coastal populations: osteomyelitis and treponematosis by Hutchinson. While it is possible that osteomyelitis is a result of treponemal infection, Hutchinson classified it separately as it can also result from other pathogens (2002:119). Hutchinson identified a minimum of 18 individuals with systemic infection from the Late Woodland Outer Coast. Healed stellate lesions were noted in both sexes (nine males, seven females) from the Outer Coast. Postcranial lesions indicative of treponemal infection were recorded also recorded in outer coastal Late Woodland populations. Hutchinson noted several Outer coastal individuals with tibiae having anterior crest apposition; which are lesions that have been associated with the presence of treponemal disease (Hutchinson 2002:123). Additionally, saber tibiae were observed in the outer coastal populations, although less frequently. Long bones with node and expansions that had superficial cavities were also common in the Outer Coast. At West, Burials 1 and 2 both exhibited infectious disease. Burial 1, as previously discussed, contained tibiae and fibulae that displayed sclerotic activity and cancellous expansion. Burial 2 contained one instance of treponemal disease (stellate lesion), as well as a cloaca for drainage, as well as evidence of infection in a right fibula exhibiting a cloaca. In total, 19% of the long bones from Burial 2 (n=68) displayed periosteal reactions that could be attributed to infectious disease. There was a very significant difference found between West and the other Outer Coast sites (χ=8.30; p<0.01).

Osteoarthritis

In Hutchinson's study of osteoarthritis in outer coastal populations, he noted a multitude of skeletal responses. These included Schmorl's nodes, osteophytes, compression fractures, joint surface erosion, and eburnation (Hutchinson 2002:103). Outer coastal populations commonly

exhibited osteophytic spurs and Schmorl's nodes in the vertebrae. Of the 579 vertebrae from all the West burials, 43 exhibited some form of arthritic activity. There was an extremely significant difference between West and the other Outer Coast sites (χ=184.74; p<0.0001). The long bones (femurs, ulnae, radii, humerii, and fibulae) did not display statistically significant frequencies of arthritic activity at either West or the Outer Coast as a whole (<1% for both). Interestingly, Baum 1 and West Burial 2 exhibited fusion of elements of several feet. In Baum 1, a left navicular, cuboid, and first and second cuneiforms were all fused. In West Burial 2, three sets of phalanges were fused (Hutchinson 2002:106). Radiographs conducted for these feet displayed no evidence of fractures or lytic involvement indicative of a disease process. These few instance of fused elements are unique, however statistically insignificant within the wider West and Outer Coast contexts.

Trauma

In the study of trauma outer coastal Late Woodland groups, Hutchinson found that there were ten occurrences in the outer coastal groups (2002:107). Trauma in the outer coastal groups was more frequent in the arms (the ulnae and radii). Though, the Baum site had an occurrence of broken ribs. Burial 2 at West was the only burial in which trauma was recorded. The healed fractures of two ulnae fit within the frequency pattern that Hutchinson found in the outer coastal populations. Additionally, a healed blunt force trauma, compression fractures of two thoracic vertebrae, and a damaged clavicle were recorded. Apart from the compression fracture, it appears that West and the outer coastal sites did have evidence trauma, but not at any significant frequency.

Differential Health Status of Males and Females at West and the Late Woodland Outer Coastal Sites

Dental caries were noted in all burials at West. In the primary Burials 4 and 5, which contained a male and two females, all of the individuals displayed carious lesions, showing no significant difference between them. While Burials 1 and 2 also had dental caries, due to their commingled and fragmented remains, it is difficult to designate between males and females in these two burials. In Hutchinson's original study he found a significant difference between males and females ($p<0.01$). At West, there was no significant difference between males and females ($\chi=0.00$; $p=1.00$). After incorporating the new findings at West into the existing data from the Outer Coast, there is still a statistically significant difference between males and females ($\chi=47.00$; $p<0.0001$).

Dental enamel hypoplasias were noted in all the burials at West. The primary burials 4 and 5 as well as the commingled Burials of 1 and 2, demonstrate that males and females were affected by nutritional stress early in life. West males and females were not statistically different from the other Outer Coast sites (Males: $\chi=0.00$; $p=1.00$; Females: $\chi=0.00$; $p=1.00$). With the West data incorporated into the existing outer coastal data, there was no significant difference found between males and females in terms of enamel hypoplasia frequencies ($\chi=2.57$; $p=0.11$).

While external auditory exostoses were expected to be observed at West due to its proximity to the water and marine food resources, none of the burials exhibited this pathology. In Hutchinson's analysis, only one male from Baum 7 and one indeterminate sex from Baum 1 exhibited this pathology.

Porotic hyperostosis was recorded in Burials 2 and 4 from West. In Burial 4, the pathology was noted in the process of healing in the female. In Burial 2 there was a 30% frequency amongst the cranial elements recovered. Of these, seven were determined to be female, while the sex of the others could not be determined. In Hutchinson's study, he found that outer coastal females were affected at a higher rate than males (females: 63%; males: 56%) (2002:98). When the additional data from West was incorporated, there appears to be an extremely significant difference between males and females (χ=11.04; p<0.0001). Females appear to have experienced porotic hyperostosis at higher frequencies than males in the Late Woodland Outer Coast.

The evidence of infectious disease was recorded in Burials 1, 2, and possibly 4. There was sclerotic activity noted in the male in Burial 4 that could possibly be attributed to infectious disease. However, Burial 1 and Burial 2 had evidence of infectious disease in skeletal elements of indeterminate sex. Hutchinson noted that eight males (23%), seven females (17%), and three indeterminate sex adults (1%) were observed to have stellate lesions. Additionally, osteomyelitis and periostitis were recorded in 12% of females and 8% of males in the outer coastal population. While these diseases cannot be definitively linked to treponematosis, they are commonly associated with it. Where systemic infection was identified, more outer coastal males (16%) were affected than females (12%) (χ=6.67; p<0.01)(Hutchinson 2002:119). Sex determination is the primary factor in resolving the frequency of infectious disease differences in West and the Outer Coast. Due to the indeterminate sex of the elements affected in Burials 1 and 2, the data cannot be incorporated into the frequencies calculated previously by Hutchinson.

Osteoarthritis was recorded in both Burials 2 and 4 at West. Both individuals (male and female) in Burial 4 exhibited osteoarthritis at various joint locations. While osteoarthritis was

recorded in multiple skeletal elements in Burial 2, determining the sex of the affected element is impossible due to the commingled remains of the secondary burial context. In Hutchinson's study of outer coastal groups, he found that in all vertebrae combined as well as other skeletal elements, males displayed osteoarthritis at statistically significant higher rates than females (2002:103). The incorporation of the data collected from the new burials support the statistically significant difference (9.6; $p<0.001$).

Trauma was recorded only in Burial 2 at West. A female exhibited healed blunt force trauma to the frontal, while there were other skeletal elements of indeterminate sex that exhibited trauma. There is insufficient evidence at both West and the wider outer coastal area to determine any difference in trauma between males and females.

Differences in Health Status between Primary and Secondary Burials of the Outer Coast

One of the goals of this research was to test the idea that there was no significant difference in health status of individuals buried in primary versus secondary burials at both West and the Outer Coast. The main issue in establishing this is the sampling of individuals in primary versus secondary burials at West and the other sites. Only three individuals have been recovered from primary burials at West compared to the large MNIs of West Burials 1 and 2, and the other large ossuaries of the other sites. However, there were 11 articulated burials at Baum in Burials 1 and 5 that also contained secondary burials. The individual information on these eleven articulated burials in terms of sex and pathologies was unavailable for this research. The only information on these articulated burials is that they were in burials that also contained secondary burials and that both sexes were represented (Phelps 1980). Therefore this study only attempted

to incorporate the data on the West primary burials. Taking into account the small sample of primary burial individuals (West Burials 4 and 5) compared to secondary burials at West, the statistical frequencies of the West primary burials, West secondary burials, and the other outer coastal secondary burials are listed in Table 4.15. The primary burials at West are similar to the site's secondary burials in carious lesions, external auditory exostoses, and porotic hyperostosis frequencies. However, the secondary burials at West combined have slightly higher rates of the other pathologies. The primary burials are also similar to the wider Outer Coast secondary burials in carious lesions and external auditory exostoses. The primary burials exhibited slightly higher percentage of teeth with dental enamel hypoplasias (47% of 96), while the combined secondary burials had only 9% of 2407 teeth. Otherwise, the outer coastal secondary burials had higher frequencies of all other pathologies. The following chapter is a discussion of the recent results from West, as well as the comparative analyses results listed in this chapter.

Table 4.15 Pathology Frequencies of West Primary and Secondary Burials and Other Late Woodland North Carolina Outer Coastal Secondary Burial Sites (West 2 and comparative data from Hutchinson 2002).

Pathology	Primary Burials 4 and 5 from West	Secondary Burials 1 and 2 from West	Secondary Outer Coastal Burials (including West 1 and 2)
	% / n	% / n	% / n
Carious Lesions (% of adult teeth)	14%/96	11%/189	19% / 2407
Abscesses (% of associated adult teeth)	1%/96	9%/189	32% / 2407
Enamel Hypoplasias (% of adult teeth)	47%/96	N/A	9% / 2407
Periosteal Reactions (% of long bones)	6%/18	22%/89	12% / 1157
Porotic Hyperostosis (% of cranial vault bones)	13%/8	26%/145	34% / 460

External Auditory Exostoses (% of individuals)	0%/3	0%/143	4% / 194

Chapter 5: Discussion

The new data generated from analyses of the recently excavated Burials 4 and 5 from the West Site provide the means to conduct a comparative study with Burials 1 and 2, as well as previous studies of other Late Woodland outer coastal North Carolina sites. The increased sample size from West provides a better understanding of biological adaptation in this microenvironment. This study sought to establish whether the recently excavated burials were consistent with Dale Hutchinson's overall findings of both West Burial 2 and other Outer coastal North Carolina populations. Consistent with previously studied coastal sites, there should be signs of nutritional stress and/or diseases listed in the background chapter, including dental enamel hypoplasias, carious lesions, abscesses, periosteal reactions, porotic hyperostosis, and external auditory exostoses. Additionally, there should be neither significant difference between males and females in health status nor a significant difference in the health status of between individuals buried in primary versus secondary burials at West, as well as in the wider coastal burial program. It was also expected that there would be no significant difference between which sex was buried in primary versus secondary burials. Finally, there was an expectation that one could establish that Burials 4 and 5 were in fact primary burials and were part of a larger burial ritual involving the secondary burials at West. This chapter is an analytic discussion of the burials at West, as well as the other contemporary outer coastal sites, in which any patterns of paleopathology data and mortuary activity of the Algonkians during the Late Woodland will be illuminated.

Overall Health within the Late Woodland West Site

The overall health at West during the Late Woodland is consistent with the pattern of declining health related to the transition to agriculture. All of the burials from West exhibited a high frequency of dental caries (cavities) consistent with the poor nutritional value and high sugar content of corn, typical for populations intensifying cultivation of this crop (Larsen et al. 2002). The carious lesion frequencies support an increase in corn crop consumption. As stated previously in chapter 2, the sugars found in corn contribute to increased cavities found in native populations during the transition to agriculture period. Abscesses were noted in Burials 1, 2, and 4, which can be attributed to untreated dental caries allowing infection to spread affecting the bone.

It appears that continued consumption of local marine resources, if it did continue at this site after the agriculture transition, did not alleviate this nutritional stress. External auditory exostoses were expected in outer coastal groups like West, where it was thought that there was a continued exploitation of marine resources. However, the lack of external auditory exostoses does not mean that marine resources were no longer gathered or consumed, but it does support the likelihood that this resource was not being exploited as frequently at this site during the Late Woodland.

The frequency of enamel hypoplasias indicates that the majority of the Late Woodland population at West could have suffered nutritional disruption between the ages of one and six years, but this can also be associated with weaning stress which is also a common cause of dental enamel hypoplasias. It was also not uncommon for individuals to experience and survive more than one episode of physiological stress during childhood as evidenced by multiple individuals from the various burials exhibiting multiple periods of stress.

Porotic hyperostosis, which can develop due to iron deficiency, was noted in only one skeleton in Burial 4, and in 30% of the cranial vault bones from Burial 2. Burial 4 Skeleton 1, the female, exhibited porotic hyperostosis in both the left and right sides of the frontal bone, but significant healing was well under way at the time of death. In Burial 2, most of the adults' and subadults' lesions were found to be in the process of healing.

Evidence of infectious disease was noted in some of the of the West burial remains. At least one individual in Burial 1 exhibited unilateral sclerotic activity and cancellous expansion on tibiae and fibulae (See Figure 5.1). Sclerotic activity, woven bone, and especially cancellous expansion are common manifestations of infectious disease. Skeleton 2 of Burial 4 exhibited some sclerotic reactions on the left fibula that may possibly be attributed to infectious disease. Burial 2 contained one instance of treponemal disease (syphilis or yaws) in a frontal bone that exhibited a stellate lesion, as well as a cloaca for drainage in a clavicle. Burial 2 also had evidence of infection on the distal end of a right fibula exhibiting a cloaca. In total, 19% of the long bones from Burial 2 (n=68) displayed periosteal reactions that could be attributed to infectious disease. While Burial 5 did not exhibit any signs of infectious disease, it appears that infectious disease was not uncommon at West during the Late Woodland period.

Arthritis and osteoarthritis were noted in only Burials 4 and 2. The female in Burial 4 exhibited mild arthritis in both the upper arms (humerii) at the shoulder joint as well as at the right elbow. The male in Burial 4 also exhibited mild arthritis at the shoulder as well as displaying arthritic activity on left and right hip joints and at the left knee joint. He also exhibited osteophytes in two lumbar vertebrae. These symptoms can be indicative of a difference in

Figure 5.1 Burial 1 Left Tibia with Unilateral Sclerotic and Woven Bone Activity on the Posterior side (Inset: Magnified Picture of Sclerotic and Woven Bone Activity on the Interior Portion of the Upper Part of the Tibia).

activity levels in males and females of this population. That the female exhibits arthritis in the shoulder and at the elbow may indicate that she was using these limbs repeatedly in activity that strains these joints. The male's exhibition of arthritis in the pelvis indicates a repeated wear on the lower body in his daily activity. In Burial 2, 7% of all the vertebrae within the ossuary displayed osteophytic lipping, of which seven of the 7% also displayed degenerative joint disease. Osteophytic lipping is the formation of bony spurs on the vertebral body. Additionally, two displayed Schmorl's nodes, which occur when the spinal disc's soft tissue pushes into the bony tissue of the adjacent vertebral body. Schmorl's nodes are associated with continuous wear on the spine and are frequently accompanied by arthritis (Hilton et al. 1976). Since Burial 2 is a

commingled burial, it is impossible to say whether these vertebrae were male or female, but it could indicate a level of activity that produced strain, wear, and tear on the back, which could have been the result of repetitive heavy lifting, or constant bending over. Burials 1 and 5 did not have any indications of arthritic activity. It is understandable that Burial 5 did not have any symptoms of arthritis due to the young age of the individual; however, it is unclear why none of the individuals in Burial 1 displayed any symptoms of arthritis.

Trauma was only noted in Burial 2 at West. Interestingly, there was one instance of blunt force trauma to the frontal bone with indication of healing. Because of its location on the skull, and the evidence of healing, it is unlikely this was the cause of death. There were also two instances of healed fractures recorded on the medial portion of the lateral (outer) side of two ulnae in two separate individuals. These fractures could have been from a fall or some other instance in which the forearm was on the receiving end of forceful impact (Passalacqua and Fenton 2012). There was a compression fracture of thoracic vertebrae 11 and 12. This type of fracture is commonly attributed to osteoporosis, and the subsequent weakening of the bone (Brickley 2002). Finally, periostosis was recorded in a clavicle with plaquing and a cloaca for pus drainage. Periostosis is the irregular deposition of periosteal bone (Venes 2009:1635). The periostosis coupled with plaquing and a cloaca could be indicative of some sort of trauma to the collar bone, and was in the process of healing at the time of death. The absence of trauma in the other West Burials could be attributed to the relatively small sample size in the other burials. Burial 2 is by far the largest of the four (MNI=135), while Burial 1 had an MNI of eight, and Burials 4 and 5 had MNIs of two and one respectively.

Overall, the recently excavated burials at West appear to fit with Hutchinson's findings in the larger ossuary Burial 2 with a few exceptions. Burials 1 and 5 did not show any evidence of

porotic hyperostosis, while Burial 5 also did not display any evidence of periosteal reactions or abscesses. While these burials did not display these pathologies it does not mean that they were atypical for the site during this period, the lack of evidence could be due to the discrepancy in sampling number between the burials. Also, while this study expected to find external auditory exostoses in relation to marine resource exploitation, the lack of findings in this study is consistent with Hutchinson's study of Burial 2. The lack of evidence of this pathology does lend support to the argument that people of the West site did not rely as heavily on marine food resources during the Late Woodland. Burials 4 and 5 appear to have lower frequencies of the listed pathologies expected to be observed due to previous research on both West and other outer coastal Late Woodland sites by Hutchinson (See Table 4.5 in the previous chapter). The recent findings at West coupled with those of Hutchinson's previous study lend support to an overall decline in health at the site.

Comparative Analysis

After conducting the skeletal analysis of the West burials, it was important to place the results of the West analyses in the context of other contemporary outer coastal sites. The outer coastal sites used here were those previously studied by Dale Hutchinson that included are Baum (31CK9), Hatteras (31Dr38), and Knott's Island (31CK24), as well as Burial 2 from West. The next comparative analysis was between males and females at West and the other outer coast sites. The difficulty in performing this comparison was that many of the burials were commingled ossuaries, where establishing the sex in skeletal elements where pathologies occurred was sometimes impossible. There was also an attempt in this study to determine if there

was any difference in health status between those buried in primary versus secondary burials and if there was any difference in burial treatment of males and females at West.

Overall, the West site, as well as the other outer coastal sites, showed high frequencies of dental caries at statistically significant levels. Dental enamel hypoplasias frequencies were also high in West and the Outer Coast, but there was a statistically significant difference between West and the other coastal sites. This suggests that while West was consuming corn at high levels, they appear not to have been as intensive in consumption as the rest of the Outer Coast. Only two incidents of external auditory exostoses were recorded at Baum. In this regard, the findings at West fits support the low frequency of this pathology in the Outer Coast. The scarcity of this pathology seems to support an overall decline in marine resource exploitation in the Late Woodland. However, Hutchinson (2002) suggests that geographic location and water temperature do not automatically guarantee a higher frequency of this pathology. While these outer coastal groups likely exploited marine resources to some degree, there could be other influences at work including the depth and temperature of the water, and diving techniques used.

There was an increase in porotic hyperostosis lesion frequencies at West based on this most recent analysis. While only one individual from a primary burial at West displayed this pathology, 30% of the cranial bones in Burial 2 exhibited this trait providing a great example of the higher frequency of this pathology in the outer coastal sites. However, there was no statistically significant difference in this pathology frequency between West and the other sites. Infectious disease pathologies were also found in Outer Coast sites. The frequencies were statistically significant, and imply that treponemal disease (syphilis, yaws) were present at West at much higher rates than the outer coastal sites of the Late Woodland. Osteoarthritis was also present at all the outer coastal sites. The frequency with which osteoarthritis occurs in the

vertebrae at West was significantly higher than the outer coastal sites. However, West as well as the rest of the outer coast had low frequencies of arthritic activity in the long bones with less than 1% for both. Finally, trauma was recorded in all the outer coastal sites. Interestingly, trauma was more frequently found in the bones of the arm in the Outer Coast. West fits in with this outer coastal pattern as Burial 2 exhibited trauma to two ulnae. Additionally, West had an occurrence of blunt force trauma, trauma to the clavicle, and Baum had an incident of several broken ribs.

It was much more difficult to analyze the difference in health status of males and females at West due to the fragmented and commingled remains of Burials 1 and 2. While pathologies could be recorded, it was much more difficult to assign sex to fragmented skeletal elements that exhibited these pathologies. Thus, this research drew on not only from West, but the overall study of health in males and females of the outer coast. Dental caries were noted in all burials at West of both male and female individuals. In Hutchinson's study of the outer coastal sites, he found that males were affected slightly more than females. At West there was no significant difference between males and females. After incorporating the new findings at West into the existing data from the Outer Coast, there is still a statistically significant difference between males and females. Hutchinson (2002) suggested that this slightly higher occurrence in males was due to men and women partaking in different food processing behaviors in which men's teeth were affected more often than women.

Dental enamel hypoplasias were also noted in all the burials at West, indicating males and females were both equally affected by early life nutritional stress. In Hutchinson's study of the Outer Coast, he found no significant difference between males and females exhibiting this pathology. West males and females were not statistically different from the other Outer Coast sites. With the West data incorporated into the existing outer coastal data, there was no

significant difference found between males and females in terms of enamel hypoplasia frequencies. No evidence of external auditory exostoses were found in any of the burials at West, and there were only two incidents as a whole found in the outer coastal sites. The scarcity of this pathology cannot allow for a comparison to be drawn between males and females, other than they appear to be equally unaffected. As well as, this may also call into question the presence of this pathology as an indicator of relying on marine food resources. Porotic hyperostosis was found to occur more frequently in females than males in Hutchinson's study of outer coastal groups. At West, the female in Burial 4 as well as seven females in Burial 2 were found to exhibit this pathology. When the additional data from West was incorporated, there appears to be a significant difference between males and females. Females appear to have experienced porotic hyperostosis at higher frequencies than males in the Late Woodland Outer Coast. While it is impossible to say with absolute confidence that females at West suffered more nutritional stress than males, there is at least some evidence to suggest that West likely fits this pattern. This may be linked to pregnancy and/or breast feeding stress.

Evidence of infectious disease was found at West and the outer coastal area. Where sex could be determined, males had slightly higher frequencies of infectious disease than females. Due to the indeterminate sex of the elements affected in Burials 1 and 2 at West, the data cannot be incorporated into the frequencies between males and females calculated previously by Hutchinson. Osteoarthritis was recorded in the male and female of Burial 4, but affecting different areas of the body. The female was affected in the upper body while the male exhibited osteoarthritis in the lower body as well as the spine. It was impossible to determine sex for skeletal elements exhibiting osteoarthritis in the commingled Burials 1 and 2. The incorporation of the data collected from the new burials support the statistically significant difference. These

higher frequencies of osteoarthritis in males demonstrate greater physical activity levels than that of females, especially in relation to the use of the vertebral column. The difference suggests that men and women carried out different subsistence duties affecting joint areas differently in the sexes. Trauma was another pathology that was too scarce and difficult to compare by sex. One female at West in Burial 2 was recorded with blunt force trauma; however, the lack of evidence at both West and other outer coastal sites cannot substantiate a difference between males and females.

This research endeavored to demonstrate that there was no significant difference in health status of individuals buried in primary versus secondary burials at West and the other outer coastal sites. The main issue in addressing this is the sampling of individuals in primary versus secondary burials. In total, there are 14 in primary burials (including the eleven at Baum) compared to the large MNI total of the secondary burials. Additionally, the individual information on the articulated burials at Baum in regards to sex and pathologies was unavailable for this research, so this study only attempted to incorporate the date from the West primary burials. This study strived to take into account this sampling issue in determining a difference in health status of these individuals. The primary burials at West are similar to the site's secondary burials in carious lesions, external auditory exostoses, and porotic hyperostosis frequencies. However, the secondary burials at West combined, have slightly higher rates of the other pathologies. The primary burials are also similar to the wider Outer Coast secondary burials in carious lesions and external auditory exostoses. The primary burials exhibited slightly higher percentage of teeth with dental enamel hypoplasias (47% of 96), while the combined secondary burials had only 9% of 2407 teeth. Otherwise, the outer coastal secondary burials had higher frequencies of all other pathologies.

This research was also aimed at determining whether there was any significant difference in individuals buried in primary versus secondary burials in terms of sex at West. There was nothing to indicate that males and females were treated differently in terms of who was buried in primary or secondary burials. It is much more likely that these two primary burials were part of a larger burial program occurring during the Late Woodland.

Burial Practices at West

One of the final goals of this research was to attempt to determine that the primary Burials of 4 and 5 were part of a larger burial program occurring at West. Primary burials at the site were classified by the presence of articulated burials while the secondary burials at the site were classified by the presence of bundled and scattered skeletal remains of multiple individuals. The West site offers a unique and rare opportunity to understand primary and secondary burials during the Late Woodland, a period in which ossuary burials are much more commonly found. In the outer coastal sites of North Carolina, Baum was the only other site to have both primary and secondary burials until West revealed its two primary burials. Baum's articulated burials differ from those found at West, in that the articulated burials were found amongst bundle burials. At West, the articulated burials were found apart from the ossuary burials. However, because Burials 4 and 5 were discovered due to their erosion into the sound, it is entirely possible that these burials contained not only more articulated burials, but may have also contained bundle burials that have long since eroded out into the Currituck Sound.

There have been multiple historical accounts of the burial rituals of Algonkian groups in which articulated remains were exhumed and deposited as discreet bundles within an ossuary. There have been multiple ethnohistoric accounts that indicate that interment of the dead was not

a single event, but a larger ritual. Every stage of the burial ritual would impact the articulation of the remains and the organization of the articulated and ossuary burials. Hutchinson and Aragon (2002) state that primary burials located near ossuaries are suggestive of collective ossuaries being the end result of such a practice.

Since there are no direct accounts of Algonkians of this region participating in the ritual of exhuming articulated remains and depositing in a secondary context, one must infer the burial program occurring at West from the archaeological and historically documented evidence. Apart from the historical accounts of such a practice, one must consider the proximity and contemporariness of the primary and secondary burials. West has Late Woodland primary and secondary burials on site. There is nothing to indicate a difference in status of those buried in the primary and secondary contexts. Additionally, the site of Baum also has both types of burials. Furthermore, the articulated remains are found in conjunction with ossuary bundles, indicating that such a burial program was taking place at this nearby contemporary site.

While it is not possible to say with absolute certainty that Burials 4 and 5 were part of a larger burial ritual, it is highly probable that they were. With two contemporary ossuary burials on site, it is likely that these articulated burials were destined for an ossuary context. The reasons why these burials did not make it to an ossuary are unclear. Three possibilities were presented in this study: (1) these burials were forgotten therefore never making it to an ossuary; (2) the site was abandoned before the burials could complete their ritual journey; or (3) these primary burials were the intentional final resting places with no intention of interment within a secondary context. The first two possibilities are the most likely, but without further evidence, archaeologically or documentary, the burial program at West cannot be clearly defined.

Outer Coastal North Carolina, Georgia Bight, and La Florida

One final aspect of this research was to draw bioarchaeological comparisons between West and the outer coastal region of North Carolina with previously studied contemporary sites in the southeast to see how outer coastal North Carolina fits within the wider southeastern region. The background chapter provided an overview of the well-documented regions of Georgia Bight and La Florida. After discussion of the overall health at West and the outer coastal North Carolina sites it is important to understand how West and North Carolina's Late Woodland Outer Coast compares to other sites in the southeast to better understand how this area of North Carolina fits within the larger southeastern region's health status.

Larsen and Hutchinson's analysis of contemporary Georgia Bight populations outlines some broad health themes. First, there was an overall decline in dental enamel hypoplasias, osteoarthritis, porotic hyperostosis, and cribra orbitalia, implying that the general health was not affected as negatively during this period as that of the coastal North Carolina. In Larsen's analysis of La Florida groups, he found that while there was an increase in frequency of dental enamel hypoplasias in the agriculture groups. Dental caries, porotic hyperostosis and cribra orbitalia lesions, as well osteoarthritis increased in the La Florida populations. Table 5.1 outlines the frequencies of pathologies of combined Outer Coast North Carolina sites (including West) compared to La Florida and Georgia Bight. The data presented from La Florida and Georgia Bight were combined in the publications used for pathology frequencies (Larsen, ed. 2001; Lambert, ed. 2000). Some of the data were not available, including abscesses, periosteal reactions, and external auditory exostoses. Both the outer coastal North Carolina sites and Georgia Bight and La Florida had similar frequencies of carious lesions and dental enamel hypoplasias. However, there is a large difference between North Carolina and Georgia Bight and

La Florida in terms of porotic hyperostosis frequencies. The sites of North Carolina had significantly more instances of porotic hyperostosis (34%) than La Florida and Georgia Bight (3.3%). This large difference indicates that the outer coastal population of North Carolina was experiencing much more nutritional stress than the contemporary populations of Georgia Bight and La Florida. After running chi square, there was an extremely significant difference found between outer coastal North Carolina and the Georgia Bight and La Florida in the frequencies of these three pathologies: carious lesions (χ=92.00; p<0.0001), dental enamel hypoplasias, (χ=47.14; p<0.0001), and porotic hyperostosis (χ=32.44; p<0.0001).

Table 5.1. Outer Coastal North Carolina and La Florida and Georgia Bight Pathology Frequencies.

Pathology	Outer Coastal North Carolina	La Florida and the Georgia Bight
	% / n	% / n
Carious Lesions (% of adult teeth)	19%/2503	17%/4876
Abscesses (% of associated adult teeth)	31%/2503	N/A
Enamel Hypoplasias (% of adult teeth)	10%/2503	9%/4876
Periosteal Reactions (% of long bones)	12%/1175	N/A
Porotic Hyperostosis (% of cranial vault bones)	34%/468	3.3%/303
External Auditory Exostoses (% of individuals)	4%/197	N/A

West and the wider outer coastal area of North Carolina exhibit similarities to both the Georgia Bight and La Florida groups. West and the outer coastal area exhibited similar frequencies in dental caries and dental enamel hypoplasias.

Analyses of outer coastal North Carolina, Georgia Bight, and La Florida provide some overarching themes while also showing regional variation in terms of health during this period. The information of all three of these regions provides insight into a better understanding of the timing and impact of agriculture on coastal groups of the Late Woodland period. While the goal of this research was to determine how similar these regions were, this study also revealed the variation in regional adoption and response to agriculture both culturally and in terms of health.

The data from the recently excavated burials from West provided some unexpected comparative results. With the incorporated data, West displayed sometimes higher or lower frequencies of the pathologies than its contemporary outer coastal neighbors. While some of the data of the sex of individuals, as well as the information of pathologies linked to specific individuals was either unavailable or unattainable due to commingled remains, this study was able to provide new comprehensive and comparative discussions on West, the North Carolina Outer Coast, and the wider southeast during the Late Woodland.

Chapter 6: Conclusions

The foundation of this research was to better understand the Late Woodland period (AD 800-1650) health, disease, subsistence, and mortuary practices within the distinctive contexts which the Algonkians lived during this period. Research on the Late Woodland period (AD 800-1650) inner and outer coastal sites in North Carolina has stressed this period's uniqueness within the state's prehistory. The transition from the Middle to Late Woodland saw a shift away from a reliance on hunting and gathering to an increasing dependence on agriculture. The numerous and varied microenvironments within this region makes the study of subsistence practices, health, and nutritional status of these prehistoric groups a complex enterprise. The previous excavation and research by Dale Hutchinson and others has explored how transitions such as agricultural intensification or the arrival of European settlers have impacted the biology of Inner and Outer Coast inhabitants. Specifically, Hutchinson studied human skeletal material recovered from coastal Middle and Late Woodland sites to explore how the reliance on maritime resources affected the timing and degree of agricultural intensification, how the increased consumption of domesticated maize impacted health and disease in Late Woodland populations, and how disease and nutrition differed between populations relying on agriculture versus marine hunting and gathering.

The primary goal of this thesis research was to further investigate the health and disease of recently excavated burials at the outer coastal West site in Currituck, NC. The human remains previously excavated from the site were included within Hutchinson's study of diet and paleopathology of Late Woodland outer coastal sites for a more comprehensive understanding of health at West. It was expected that an increased sample size from this outer coastal site may expand our understanding of biological adaptation in this microenvironment.

The recent excavations also revealed diverse burial patterns at the West Site. This study thus included using biological and material cultural data to tease out possible explanations for utilizing primary vs. secondary burial at the site and at other outer coastal Late Woodland sites with similarly multifaceted burial programs. Other instances of articulated primary burials from the region were explored to identify intersite patterns by burial practice in terms of health, demographic variables (age, sex), context, and other aspects of mortuary treatment, e.g., grave goods, etc. that would explain the different mortuary treatment.

A study of paleopathology and mortuary practice comparisons of the recently excavated burials at the West site was expected to produce results that are congruent with previous work of Dale Hutchinson. The first was that there should be signs of nutritional stress, and/or disease consistent with previously studied coastal burial sites. Another expectation was that there should be no significant difference in health status between individuals buried in primary versus secondary burials at West, as well as in the wider coastal burial program. As well, it was expected there should not be any significant difference between males and females in health status. There should also not be any significant difference between which sex was buried in primary or secondary burials. Finally, there was an expectation that one could establish that Burials 4 and 5 were in fact primary burials and were part of a larger burial ritual involving the secondary burials at West. Primary burials at the site were classified by the presence of articulated burials while the secondary burials at the site were classified by the presence of bundled and scattered skeletal remains of multiple individuals.

This research provides not only an understanding of health at West, the data when incorporated with the data of other contemporary local sites, also aids in the construction of the Late Woodland lifeways of the wider outer coastal region of North Carolina. The new data

generated from this thesis continues to build a picture of North Carolina's Outer Coast during a period in which subsistence strategies were beginning to shift towards agriculture. In turn, the sites of this region can be understood in the wider context of the contemporary southeast undergoing the same transition.

Recommendations for Future Research

This study sought to address some key issues in understanding health during the Late Woodland, a period in which many regions, including the coastal region of North Carolina saw a transition to a stronger dependence on agriculture over foraging. The main purpose of this study was to gain a better insight into the health status of individuals living at West during this period, and to understand how West fits into the outer coastal region of North Carolina. This study provided a comparative analysis on many broad themes of health, all of which warrant future study. There is enough data on the inner and outer coastal groups that research into why there are discrepancies in health status between these two areas is worthy of exploration. This research should include not only what, if any, differences occur, but if there are similarities, what this implies in terms of similar subsistence strategies.

Another topic that should be addressed is the burial patterns of outer and inner coastal North Carolina. The predominant burial found in Late Woodland coastal North Carolina is the ossuary burial. West provides the first instance in the outer coastal region of primary burials buried apart from ossuary burials. It is likely that these burials were part of a larger burial ritual occurring at the site, and warrants further research. The study should seek out other instances, if any, in the mid-Atlantic or southeast that have contemporary similar burial sites. Additionally,

there should be research conducted that incorporates the data on the articulated burials from Baum to determine if these individuals are similar to those of the primary burials at West in health status. This data can then be incorporated further into the understanding of health status of the primary and secondary burials of the Outer Coast. Also, it would be informative to acquire the data on abscesses, periosteal reactions, and external auditory exostoses from La Florida and the Georgia Bight to have a more comprehensive study of Outer Coast North Carolina and these contemporary southeastern sites.

This thesis sought to accomplish multiple goals. First and foremost was to record and synthesize the data of West while providing information on the health and burial practices at the site. Second, was to see where West fit within the broader context of the outer coastal region. Third, this research wanted to address any demographic differences in terms of health or burial treatment at West and the outer coastal area. Fourth, this study wanted to establish a pattern that defined primary and secondary burials and whether there was a larger burial program occurring at the site. Finally, this research sought to place the outer coastal region of North Carolina into context with contemporary southeastern coastal sites. All of these goals were addressed and achieved where possible. There are still many unanswered questions about the Late Woodland and the health of these outer coastal populations, but hopefully this research has provided answers as well as foundations for future research.

References

Brickley, Megan

2002 An Investigation of Historical and Archaeological Evidence for Age-Related Bone Loss and Osteoporosis. International Journal of Osteoarchaeology 12 (5):364-371.

Brooks, S.T., and J.M. Suchey

1990 Skeletal Age Determination Based on the Os Pubis: A Comparison of the Ascádi-Nemeskéri and Suchey-Brooks Methods. Human Evolution 5:227-238.

Buikstra, Jane E., and Lane A. Beck.

2006 Bioarchaeology: The Context Analysis of Human Remains. Burlington: Academic Press.

Buikstra, Jane E., and Douglas H. Ubelaker.

1994 Standards for Data Collection from Human Skeletal Remains. Fayetteville: Arkansas Archeological Survey.

Daniel Jr., I. Randolph, Kandace R. Detwiler, C. Margaret Scarry, Mary Ann Holm, and Dale L. Hutchinson.

1999 Archaeological Excavations at Hammocks Beach West (31ON665): A Woodland Shell-Midden on the North Carolina Coast. Greenville: Occasional Papers of the Phelps Archaeology Laboratory, 1.

Goodman, Alan H., and Jerome C. Rose.

1990 Assessment of Systemic Physiological Perturbations from Dental Enamel Hypoplasias and Associated Histological Structures. Yearbook of Physical Anthropology 33:59-110.

Hertz, Robert.

1907 Death and the Right Hand. In *Death, Mourning, and Burial: A Cross-Cultural Reader*, ed. Antonius Robben, 197-212. Malden: Blackwell Publishing.

Hickerson, Harold.

1960 The Feast of the Dead among Seventeenth Century Algonkians of the Upper Great Lakes. American Anthropologist 62 (1):81-207.

Hilton, R.C., J. Ball, and R.T. Benn

1976 Vertebral End-Plate Lesions (Schmorl's Nodes) in the Dorsolumbar Spine. Annals Of The Rheumatic Diseases 35:127-132.

Hutchinson, Dale L.

2002 Foraging, Farming, and Coastal Biocultural Adaptation in Late Prehistoric North Carolina. Gainesville: University Press of Florida.

Hutchinson, Dale L., and L.V. Aragon
2002 Collective Burials and Community Memories: Interpreting the Placement of the Dead in the Mid-Atlantic and Southeastern United States with Reference to Ethnographic Cases from Indonesia. In *The Space and Place of Death*, edited by H. Silverman and D. Small. Special Publication of the Archaeology Section, American Anthropological Association, Washington, D.C.

J.R.
1896-1901 The Ojibwa Indians of Parry Island, Their Social and Religious Life. Canadian Department of Mines, Bulletin 78. National Museum of Canada Anthropological Series No.17 Ottawa.

Larsen, Clark Spencer.
2000 Skeletons in Our Closet: Revealing Our Past through Bioarchaeology. Princeton: Princeton University Press.

1997 Bioarchaeology: Interpreting Behavior from the Human Skeleton. Cambridge: Cambridge University Press.

Larsen, Clark Spencer, and Dawn E. Harn.
1994 Health in Transition: Disease and Nutrition in the Georgia Bight. *In* Paleonutrition: The Diet and Health of Prehistoric Americans ed. Kristin D. Sobolik. Carbondale: Southern Illinois University.

Larsen, Clark Spencer, A.W. Crosby, M.C. Griffin, D.L. Hutchinson, C.B. Ruff, K.F. Russel, M. J. Schoeninger, L.E. Sering, S.W. Simpson, J.L. Takács, and M.F. Teaford.
2002 A Biohistory of Health and Behavior in the Georgia Bight: The Agricultural Transition and the Impact of European Contact. *In* The Backbone of History: Health And Nutrition in the Western Hemisphere eds. Richard H. Steckel and Jerome C. Rose. Cambridge: Cambridge University Press.

Lovejoy, C.O, R.S. Meindl, T.R. Pryzbeck, and R.P. Mensforth.
1985 Chronological Metamorphosis of the Auricular Surface of the Ilium: A New Method for the Determination of Age at Death. American Journal of Physical Physical Anthropology 68:15-28.

Masset, C.
1989 Age Estimation on the Basis of Cranial Sutures. *In* Age Markers of the Human Skeleton, ed. M.Y. Iscan, pp71-103. Charles C Thomas: Springfield, Illinois.

Mathis, Mark.
1992 Inspection and Recovery of Human Skeletal Remains from an Eroding Ossuary at

31CK22, Currituck County.

1994 Personal Correspondence with David Brooke.

McCall, R.D and Mark C. Griffin
1985 A Report of a Preliminary Osteological Analysis of 31CK22 Burial 1. Wilmington: University of North Carolina at Wilmington.

Moorees, C.F.A., E.A. Fanning, and E.E. Hunt
1963a Formation and Resorption of Three Deciduous Teeth in Children. American Journal of Physical Anthropology 21:205-213.

1963b Age Formation by Stages for Ten Permanent Teeth. Journal of Dental Research 42:1490-1502.

Murphy, T.R.
1959 Gradients of Dentine Exposure in Human Tooth Attrition. American Journal of Physical Anthropology 17:179-185.

Oliver, Billy
1984 Personal Correspondence with Tom Burke, Chief Archaeologist.

Ortner Donald J., and Arthur C. Aufderheide eds.
1991 Human Paleopathology: Current Syntheses and Future Options. Washington: Smithsonian Institutions Press.

Ortner, Donald J.
2003 Identification of Pathological Conditions in Human Skeletal Remains. Second ed. San Diego: Academic Press.

O'Shea, John M.
1984 Mortuary Variability: An Archaeological Investigation. Orlando: Academic Press, Inc.

Passalacqua, Nicholas V., and Todd W. Fenton.
2012 Developments in Skeletal Trauma: Blunt Force Trauma. *In* A Companion to Forensic Anthropology, ed. Dennis C. Dirkmaak, pp.400-412. Oxford: Blackwell Publishing, Ltd.

Phelps, D.S.
1980 Archaeological Salvage of an Ossuary at the Baum Site. Final Report of Research. Greenville, N.C.: Archaeology Laboratory, Department of Sociology and Anthropology, East Carolina University.

1983 Archaeology of the North Carolina Coast and Coastal Plain: Problems and Hypotheses, *In* The Prehistory of North Carolina: An Archaeological Symposium, eds.

Mark A. Mathis and Jeffrey J. Crowe, pp. 1-51. Raleigh: North Carolina Department of Cultural Resources, Division of Archives and History.

Roberts, Charlotte, and Keith Manchester.
2005 The Archaeology of Disease. Third ed. Ithaca: Cornell University Press.

Scott, E.C.
1979 Dental Wear Scoring Technique. American Journal of Physical Anthropology 51:213-218.

Smith, B.H.
1984 Patterns of Molar Wear in Hunter-Gatherers and Agriculturalists. American Journal Of Physical Anthropology 63:39-56.

Steele, D.G. and C.A. Bramblett.
1988 The Anatomy and Biology of the Human Skeleton. Texas A&M University Press, College Station, Texas.

Todd, T.W.
1921a Age Changes in the Pubic Bone. I: The Male White Pubis. American Journal of Physical Anthropology 3:285-334.

1921b Age Changes in the Pubic Bone. III: The Pubis of the White Female. IV: The Pubis of the Female White –Negro Hybrid. American Journal of Physical Anthropology 4:1-70.

Ubelaker, D.H.
1989 Human Skeletal Remains. 2nd ed. Taraxacum Press, Washington D.C.

Venes, Donald J.
2009 Taber's Cyclopedic Medical Dictionary. 21st ed. Philadelphia: F.A. Davis Company.

Ward, H. Trawick, and R. P. Stephen Davis Jr.
1999 Time Before History: The Archaeology of North Carolina. Chapel Hill: The University of North Carolina Press.