Health among the Maya: Comparisons among sites in the northern Three Rivers Region, Belize

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For my parents

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Abstract

The aim of this research is to examine the health indicators of the northern Three Rivers Region and compare the results to the larger context of health of the ancient lowland Maya. The research was completed through the analysis of the skeletal populations of three separate Maya sites: Blue Creek, Nojol Nah, and Xnoha, and by comparing results within and among the three sites for a total sample size of 222 individuals. The northern Three Rivers Region had an occupation spanning from the Middle Preclassic through the Terminal Classic periods. Therefore, health through time, as well as between the sexes, presence or absence of cultural bodily modifications in relation to health, and socio-economic status were all examined within the northern Three Rivers Region study. The osteological results presented suggest that the region was quite stable throughout its long occupation. Whereas elsewhere in the Maya region there have been studies that show dietary differences between males and females and indicate strong preferential treatment of males over females in regards to diet, the skeletal population of the northern Three Rivers Region does not exhibit such discrepancies. This likely has to do with the location of the sites in the Three Rivers Region both in terms of having access to coastal and river trade, as well as being situated near the large Alacranes and Dumb-bell Bajos, which provided a rich agricultural landscape.

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Chapter One

Introduction

The osteological investigation of skeletal remains is a practice through which much can be learnt about the past, both at the levels of the individual as well as the population. Through this lens past nutrition, disease, and overall health can all be studied and assessed. The following research is based on both biological and socio-cultural evidence to examine Maya health and society in northwestern Belize. The study presents research undertaken at three ancient Maya sites in the Three Rivers Region of northwestern Belize, an area which has not had systematic osteological study. I compare the skeletal collections in relation to health indicators, in order to establish whether there were health differences and what underlying causes might be. I also consider how the health of the region relates to the broader Maya area.

The largest of the three sites under consideration, Blue Creek, has been studied extensively since 1992 (Guderjan 2007). However, a systematic analysis of the entirety of the skeletal population had not been completed prior to my research. From what is known archaeologically, Blue Creek is not only the largest of the three sites but for reasons discussed later within this thesis was perhaps also the wealthiest of the three (Guderjan 2014). The two other sites are Nojol Nah and Xnoha. They are located less than five kilometres apart, just a few kilometres south and east of the modern borders of Mexico and Guatemala. During the times of occupation, they were of similar social status levels. These three sites together offer potential insight into change over time in the Three Rivers Region. Their occupation periods are slightly varied: Blue Creek had the longest occupational period, as it was inhabited from the Preclassic (prior to about 250CE) through to the Terminal Classic (around 900-1100CE) (Guderjan 2007). Nojol Nah was occupied from the Preclassic Period into the Classic Period (250-850CE) (Brown *et al.*, 2014). Xnoha was also occupied during the Preclassic, but it really was not until the Late Classic when the site experienced extensive construction and occupation (Guderjan 2015c). The research presented here aims to address the rates of pathologies among these three populations to provide an insight into health through time and to discover whether there were any similarities or differences in health and disease among these three sites.

The research presented here represents information from over 220 individuals, and discusses the health indicators seen throughout the region prior to Spanish contact. The skeletal collections from all three sites are housed at the Maya Research Program, in Blue Creek Village, Belize. While extensive excavations and research through the Maya Research Program have been undertaken in this area since 1992, the skeletal remains collected have received little attention. Maya health through time has long been a concern among osteologists (Wright and White 1996) as will be discussed further in Chapters 2 and 3. This research addresses questions of health amongst the three sites through osteological analysis in order to determine overall health in the region.

The main goals of the research are as follows:

1. To examine health indicators of three small to medium-sized Maya populations.
2. To determine whether there were any differences in health among the residents of the three communities.
3. To determine if there were significant changes in health through the occupational history of the region.
4. To create a paleodemographic profile for three sites which have not yet had a total analysis of the skeletal populations, and to consolidate research on a specific skeletal collection, in this case the skeletal remains housed at the Maya Research Program. This includes not only age-at-death, biological sex, and information on pathology, but also socioeconomic status, and cranial and dental modifications.
5. To provide information on Maya health and culture in this area of the Maya region in order to add to the pre-existing knowledge of Maya health patterns in Mesoamerica.

Due to the tropical environment of the Maya lowlands, preservation of skeletal materials in this region is typically exceedingly poor (Geller 2006: 258; Healy 2007: 262; Wanner 2007: 254; Webster 1997: 8). These three sites however, and Nojol Nah in particular, have been a source for skeletal remains which are in very good condition. This has created a unique opportunity to explore Maya health within the Three Rivers Region of Belize.

As the northern Three Rivers Region study examines the interrelatedness of Maya health with location, biological sex, age, and socioeconomic status, a description of the areas where the burials were excavated within each of the three sites, is presented here. This is in order to illustrate the different locations within the three sites where the human remains were excavated, and that sometimes, as will be discussed in Chapter 10, socioeconomic status in the ancient Maya world is not straightforward. The northern Three Rivers Region study employs the terminology for various structures and areas that the Maya Research Program publishes in their reports (Driver 2001; Guderjan 2007; Lichtenstein 1999). The terminology is used in my study is slightly augmented from the Tikal classification system (Bullard 1960; Lichtenstein 1999: 37; Loten and Pendergast 1984; Ricketson and Ricketson 1937). This is because the terminology used in the vast majority of the site reports, articles, and books on the three study sites employ Lichtenstein's (1999) modified terminology and as this is a study of the skeletal remains of the three sites I present the data to be uniform with those reports. However, to avoid confusion the terms for various public and private spaces as used by the Maya Research Program are defined here alphabetically.

Barrio/Neighbourhood: an area of the site composed of a few different structures, patios, courtyards, and plazas.

City-State: cities which are independent and are assumed to have been self-governing???governed by their own individual rule.

Courtyard: there are four different classifications of architectural types: courtyard, patio group, plaza, and plazuela. Courtyards entail restricted access areas bounded on all sides by structures (Lichtenstein 1999: 45). Courtyards are developed over time, having been plaza groups in which the surrounding expansion of structures has created a courtyard (Lichtenstein 1999: 45).

Patio Group: the most open of all four groups (courtyard, patio group, plaza, and plazuela) as they are built in the shape of an 'L' or a 'U' and therefore space is accessible (Lichtenstein 1999: 45).

Plaza: the largest of the four architectural types (courtyard, patio group, plaza, and plazuela) and is an open social space, typically incorporating public monumental architecture (Lichtenstein 1999: 45).

Plazuela: is slightly smaller than a plaza and is four-sided; however, a plazuela is still a large public space (Lichtenstein 1999: 45). These four architectural types (courtyard, patio group, plaza, and plazuela) can all incorporate buildings that contain burials, and indeed sometime burials are excavated not within the buildings, but instead directly under the floors of the courtyard, patio group, plaza, or plazuela.

Polity: the political and social unit of a place (Renfrew 1986); for example, reference to the Blue Creek polity is a reference to the political sphere of that city-state.

Site: the archaeological remains of a place, be that a city, neighbourhood, or structure.

Site Core: the centre of a site. For Maya sites this would mean the political centre, consisting of large monumental architecture.

Structure: the archaeological remains of a something constructed or built, a 'single complete architectural entity,' (Loten and Pendergast 1984: 14)

Social terms will be discussed in further detail in the following chapter (Chapter 2.4); however, a few terms are defined here:

Commoners/Farmers: The lowest social tier. These individuals are not well represented in the archaeology of the Maya area, this is because their houses were made of perishable materials and not much survives (refer to chapter 2).

Non-ruling elite: this social tier consists of wealthy individuals who did not rule over the polity.

Ruling elite: This group is composed of the rulers of polities, as will be discussed in Chapter 2, and includes individuals such as the *k'uhul ajaws.*

Sub-elites: Not technically of elite social status, these individuals were closer to elite status than to commoner status.

The following chapter, Chapter 2 (*The Maya: A History and Overview*), contains a broad overview of Maya culture history, focusing on the Preclassic and Classic Maya. Maya history, political structure and culture will be discussed within this chapter in order to provide a background on the culture history before delving into the bulk of the research. Chapter 2 also contains a brief contextualization of the practice of osteological study in the Maya Region as well as the osteological evidence of cultural skeletal modification in Mesoamerica. In Chapter 3, (*Osteology and Health Indicators*) the health indicators pertinent to this thesis are defined and examined in order that a base of knowledge can be obtained prior to the presentation and contextualization of results. Chapter 4 (*The Sample and Locational Context*) provides a detailed investigation into the three study sites in order to provide context for the osteological study. Chapter 5 (*Osteological Methods*) details the methods used throughout the course of the research, beginning first with how the paleodemographic profiles were created for each site, then how the various health indicators were analysed. Chapter 6 (*Results: The Skeletal Population of the northern Three Rivers Region*) presents the results of the population demographics for the complete dataset as a whole and for each site individually. This chapter focuses on age at death and biological sex ratios. Osteological results are presented in Chapter 7 (*Results: Dental Health of the northern Three Rivers Region*) beginning with dentition and dental pathologies, and continue through Chapter 8 (*Results: Skeletal Health Indicators in the Northern Three Rivers Region*) with the results of assessment of health indicators from the skeleton. Chapter 9 (*Cranial and Dental Modifications to the Skeleton*) combines cultural and osteological data when presenting the results of cultural modifications to the skeleton. Cranial and dental modification are not directly related to health; however, they are important when assessing Maya skeletal populations as they provide possible information on status or residence location. Chapter 10 (*Burial Contexts and Artefact Assemblages in the northern*

Three Rivers Region) presents the archaeological results on burial culture of the northern Three Rivers Region. Though not directly related to osteology or health, burials have the potential to provide information on socioeconomic status and other cultural factors. Chapter 11 (*Discussion*) combines the key topics detailed throughout to address the overall aim of the project. Finally, Chapter 12 (*Conclusion*) presents the conclusion and directions for future research. *Appendix A* presents summaries of each individual in the study, providing information on burial context, age at death, and biological sex. *Appendix B* presents a reference guide for each individual presenting similar information but in spread sheet format. The research presented here represents 222 individuals, from three medium-sized Maya sites, and discusses the health indicators seen throughout the region prior to Spanish contact.

Chapter Two

The Context for the Research in the Northern Three Rivers Region

This chapter presents a brief history of Maya civilization in order to provide context for the osteological study of the northern Three Rivers Region. The chapter begins with a general background on the ancient Maya so that a foundation on the Maya is in place to then expound upon in the research. This chapter includes background on geography, chronology, culture, burial customs, and diet. A section is also focused on past perceptions of the Maya, as past scholarship and ideas are important to understand so that current archaeological research can be contextualized.

Ancient Maya civilization spanned the period from roughly 1000BCE until 1100CE, although there were still functioning Maya cities at the time of Spanish Contact in the sixteenth century (Coe 2005: 11; Evans 2008: 1-3; Graham *et al*., 1989; Jones 1989: 2-4). The region encompasses much of Central America, or Mesoamerica (Figure 2.1). This includes the modern borders of southern Mexico[1], Guatemala, Belize, El Salvador, and much of northern and central Honduras. While 'Central America' or 'Middle America' refers to a geographic location, it should be noted that 'Mesoamerica' references not to a physical geography but to a cultural one (Evans 2008; Kirchhoff 1943). In its entirety, this region encompasses roughly thirteen distinct languages, although Spanish is the *lingua franca* of the region -- with the exception being Belize, where English and creole are more widely spoken in most areas (Hagerty 1996: 131-133). This chapter first examines the geography of the region, followed by a brief chronology and past theories regarding the ancient Maya – what is commonly referred to as 'the Maya mystique' (Webster 2006), before examining ancient Maya culture and society. Finally, the last section of this chapter introduces a brief summary of the history of the Three Rivers Region.

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[1] The providences of Chiapas, Tabasco, Quintana Roo, and Yucatan.

2.1 Landscape and Geography

Archaeologists and anthropologists bisect Mesoamerica into the highlands and the lowlands (Figure 2.1). The highlands are dominated by both active and extinct volcanoes, from the Chiapas region of Mexico all the way into southern Central America (West 1964). The so-called 'typical' Maya monumental architecture, writing, and cities however, are found primarily in the lowlands (West 1964). The lowlands consist a limestone platform interspersed with hills (West 1964). However, in the north, along the Yucatan Peninsula of Mexico, and the coastal plain of Belize, the terrain is extremely flat (Beach *et al*., 2009: 1710; Coe 2005: 16; Dunning et al., 2012: 85; West 1964). The limestone plateau was quarried extensively by the Maya and the limestone used in the construction of buildings. The limestone is punctured by a number of sinkholes of varying size. The sinkholes, or *cenotes* -- a Spanish mispronunciation of the Maya word *tz'onot*[2] (Coe 2005: 17) -- are created by the erosion of the limestone bedrock; the cavities created are then gradually filled with groundwater. Due to the plentiful sources of fresh water contained within the *cenotes*, many large Maya occupation sites are found within the proximity of these natural features.

[2] *tz'onot'* translates roughly to 'well.'

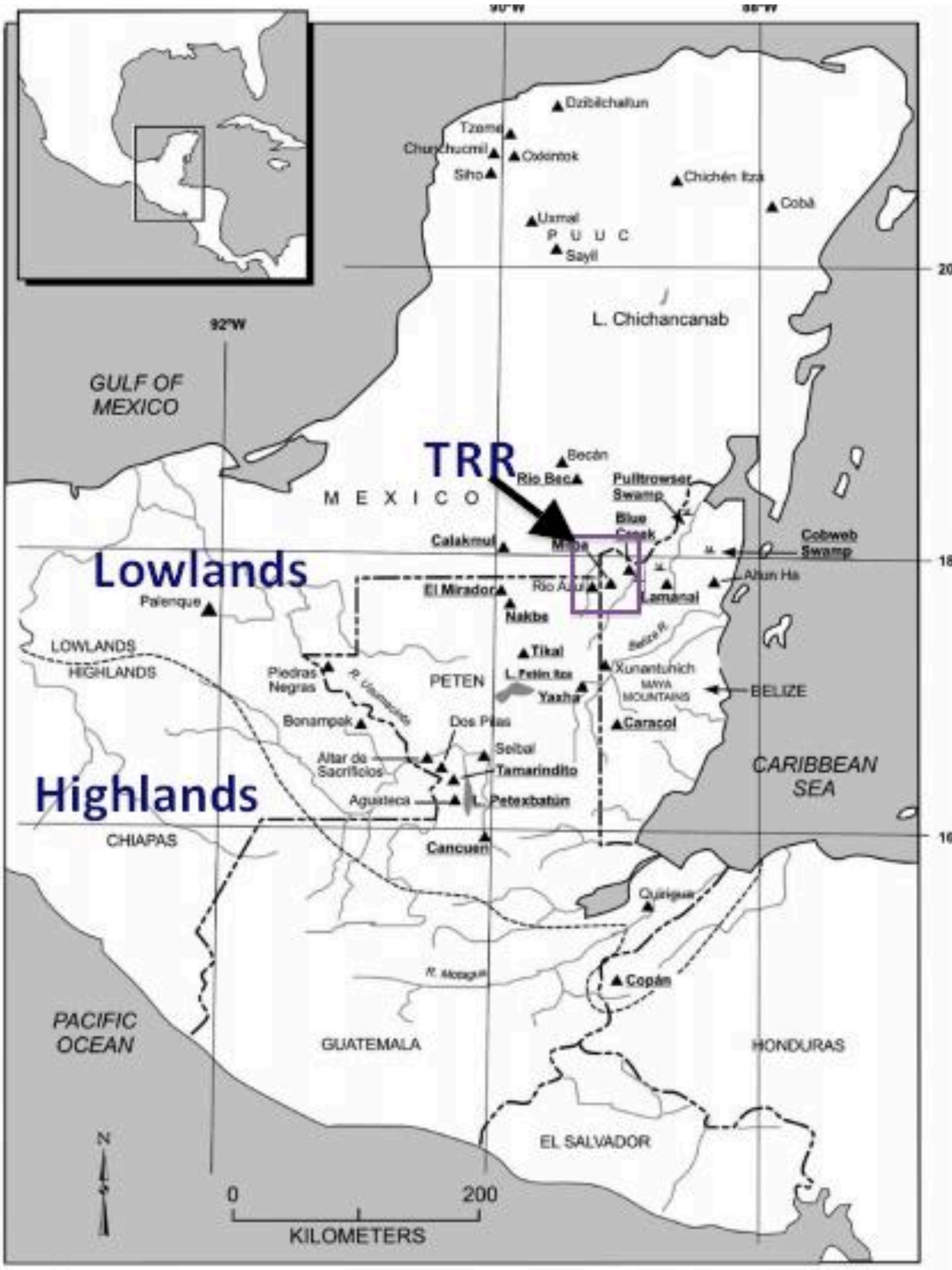

Figure 2.1: The Maya region, Three Rivers Region outlined in purple (annotated version of Beach et al. 2006: 167, courtesy of G. Hammond, 2015)

Aside from *cenotes*, other prominent features found throughout the Mesoamerican lowland landscape are *bajos*. These are low areas of fertile land, which are extremely suitable for agricultural cultivation. The productivity of the *bajos* supported the prosperity of many Maya cities, and thus many large Maya sites are found adjacent to *bajos*. For example Uaxactun, Rio Azul, and La Milpa, as well as the two largest cities of the Maya Classic Period, Tikal and Calakmul, are located in the proximity of these land features (Dunning *et al*., 2002: 271).

2.2 Chronology

Table 2.1: Conventional Maya time periods; annotated from Guderjan 2007.

Archaic	Archaic
Middle Preclassic/Formative	800-300BCE
Late Preclassic/Formative	300BCE-292CE
Early Classic	292-600CE
Middle Classic	600-800CE
Terminal Classic	800-910CE
Postclassic	910-1511CE
Spanish Contact	1511-1697CE
British Colonial (in Belize)	1697-1981
Present	1981-present

Scholars divide Maya chronology into a number of separate periods (Table 2.1). The labels used to define Maya chronology are now considered to be somewhat antiquated, and attempts at retitling and redefining these periods have been discussed (Cowgill 1996). However, the timeframes above are only used as rough guidelines, since each site was a little different, as will be discussed in further detail subsequently within this thesis. Many of the chronological terms, such as ‘Classic,’ reference back to the idea that the large-scale architecture encountered in Maya cities was on par with the monumental structures of Classical Greece or Rome. As it stands presently, the distinctions that aid in the allocation of time are based on architectural styles, artefacts, and the presence or absence of glyphic writing. The very specific dates for the Classic period, when compared to the somewhat imprecise dates for the other time periods, are due to the dates listed on the Long Count calendar by the lowland Maya (Coe 2005:87). The earliest of these calendar dates is found on the Blackman Eddy stela in Belize and dates to the equivalent of 150CE on the Gregorian calendar (Sharer 2009: 50). The last known calendar date, which is engraved on a stela at Itzimte, dates to 15 January 910CE (Coe 2005: 162). Therefore, modern scholars use these two dates to demarcate the Maya Classic period. The Postclassic Period also ends with a very specific date, the arrival of the Spanish in 1511.

The Maya are often regarded with an aura of mystery because of early ethnographic accounts and archaeological writings propagating ideas of mystique and the 'disappearance' of a civilization (Pagden 1975; Stevens 1969). However, it is important to understand that today the Maya equal a population of roughly seven and a half million people (Coe 2005: 11; McAnany and Negron 2010: 164). Therefore, the concept of the collapse of the Maya civilization trends toward overemphasis when promulgated in popular media.

2.2.1 The Archaic and Formative/Preclassic Periods

In the Maya realm, the Archaic Period refers to the six thousand years prior to the Formative, or Preclassic, period and is characterized as being pre-ceramic (Rosenswig 2014). The Archaic Period began at the end of the Younger Dryas, when the warming of the Holocene reached conditions comparable to today, and culminated when people became sedentary and began to use ceramics (Rosenswig 2014). The end of the Archaic Period is characterised by the shift from hunter-gatherer societies in Mesoamerica, to seasonal communities and sedentary villages. The period saw the rise of the domestication of maize (*Zea mays)* and other plants. Archaeologically, not much evidence remains from this time. Due to the humid conditions and soils of the lowland areas, there is little archaeological evidence remaining in this area and the vast majority of the information concerning the Archaic is from excavations and surveys in the more arid locations found in central Mexico. The issue of a lack of artefacts due to poor preservation is compounded with the fact that these sites predate the manufacture of ceramic materials (Rosenswig 2014). Despite this difficulty in obtaining much archaeological evidence, the northern Belize region is home to the highest concentration of Archaic Period sites, in particular the Late Archaic site of Colha (Rosenswig 2014).

The Preclassic Period began sometime around 800 BCE, when the first large settlements began to appear. Indeed, some of these Maya city centres of the Preclassic period are much larger than their Classic Period counterparts**.** For example, El Mirador, located within the Department of the Petén, Guatemala, is the has the largest known Maya structures, and reached its height during the

Preclassic Period (Sharer 1992: 131). It was during this time that some of the defining traits of Maya culture truly took root, such as their religious belief systems (Evans 2008: 65), characteristic cultural practices such as cranial modification (Tiesler 2010), and the construction of monumental architecture (Sharer 1992: 131). The end of the Preclassic is marked by the creation of glyphic writing, and of the Long Count calendar. Therefore, this period ends precisely with the beginning of the Classic Period, at 292 CE, as recorded in the calendar.

2.2.2 The Classic Period

The Classic Period, which lasted from 292 CE until about 950 CE is regarded as the height of ancient Maya civilization. This period is characterised by population increase (Webster *et al*., 163-165), expansion of trade networks across the landscape (as evidenced by influx of regional specific ceramic styles and raw materials) (Evans 2008: 104-107; Maggiano *et al*., 2008; McAnany and Negron 2010: 145). Population estimates for the Maya during the Classic Period are imprecise. They are often based on the Redfield and Villa Rojas (1934) ethnographic survey of the Maya community of Chan Kom. At Chan Kom during the 1930s, the number of residents per household averaged 5.6, and that is the number most commonly used today for population studies on the ancient Maya (Beach *et al*., 2014: 3; Rice and Culbert 1990: 13). Total estimates for the Maya area typically to use this method to obtain population estimates for individual Maya cities. For example, Driver (2008: 165-166) estimates that at Blue Creek there are roughly 66 structures per square kilometre. After eliminating monumental structures, and therefore only including the residential buildings, a total population estimate for Blue Creek of about 4403 individuals, or 232 people per square kilometre is obtained. This population estimate is slightly less than expected (Haviland 1972; Hudson *et al*., 2008) The small population estimate likely has to do with the nature of Blue Creek itself, as large expanses of the site were agricultural land and not residential (Guderjan 2007).

Most of what we know of ancient Maya culture is attributed to the Classic period as some of the most well-known and well-documented sites date to the Classic Period, such as Calakmul, Copán, Palenque, Tikal, among others. However, it should be noted that at present many elements of 'Classic' Maya culture are believed as being much earlier than previously thought (Demarest 2004).

2.2.3 The Maya 'Collapse' to the Historic Period

The exact causes of the collapse of the Maya civilization are widely debated (Aimers 2007; Coe 2005: 161-162; Hooton 1940; Masson 2002: 336; McAnany and Negron 2010; Saul 1972: 73; Wright 2006; Wright and White 1996). However, what remains indisputable is that the Maya people went from having thriving cities to a profusion of abandoned sites within the very short period of about 150 years, from c. 850CE to 1100CE. The northern lowlands suffered less impact than in the south (Masson 2002: 336). Hypotheses as to how and why the collapse occurred are changing (Aimers 2007). Indeed, although once viewed as a relatively linear decline, today there is sufficient evidence to suggest that pockets of both decline and growth impacted the Maya civilization variously across the period (Dunning *et al*., 2002). Typically, the collapse is viewed as having three major causes that themselves comprise of multiple factors and it is highly likely that these causes are interrelated. These are: overpopulation and accompanying environmental degradation; severe drought; and, finally, endemic warfare and competition among elites (Coe 2005: 162; McAnany and Negron 2010: 145; Wright and White 1996: 149).

Epidemic disease is another possible cause or component of the collapse, one for which the above causes -- environmental degradation, drought, warfare and overpopulation -- could all be contributing factors. According to Wright and White (1996: 152), scholars in the 1920s first theorized that epidemic disease may have contributed to the collapse. However, it was not until Hooton's publication (1940) that the hypothesis that nutritional diseases, such as anaemia, could have been a factor in the collapse began to take hold (for further information on this study refer to Chapter 3). Hooton's work opened the possibility that diseases visible on the skeleton could be studied as a means of exploring the character of the collapse and decline in culture. However, Wright and White (1996: 161) argue that the skeletal data for diseases 'do not provide unequivocal support for a nutritional collapse argument'; they further acknowledge that 'anaemia undoubtedly took its toll on the health of the ancient Maya peoples, but we find little evidence to identify it as a casual element of the collapse' (Wright and White 1996: 161). Nonetheless, the authors reiterate that infectious disease is often a factor in collapse models, along with mal- and undernutrition, and overall poor health (Wright and White 1996: 166).

Coe (2005: 161) describes the collapse of the Maya Classic Period as 'one of the most profound social and demographic catastrophes of all human history.' However, others disagree over the scale of the events. McAnany and Negron (2010: 163-165) argue that although 'in a transformed state,' Maya society not only survived, but in fact thrived during the Postclassic period, albeit in a different form and was characterised by regional differences. While the idea that the Maya flourished during this time might seem somewhat of an overstatement, the fact remains that the Maya were still occupying much of Mesoamerica, and in some cases even continuing the construction of their monumental architecture, and at times entire cities (Coe 2005: 162; Jones 1989; Masson 2002; Restall 1997; Williams and White 2006: 139). This includes in some cases continuing longstanding cultural practices such as cranial modification (Williams and White 2006) or the placement of votive *incensarios*, such as the Lancandon 'god pots,' on the top of Classic period temples and other monumental structures (Lucero and Gibbs 2007: 49; Palka 2014).

The Terminal (850-910CE) and Postclassic (910-1511CE) periods saw a hiatus in construction of new cities. There are however exceptions to that rule, including such sites as Chichen Itza (Andrews et al., 2003; Cobos and Winemiller 2001; Ringle 2004), Lamanai (Graham 2004, 2011; Pendergast 1993), Mayapan (Masson *et al*., 2010; Milbrath and Lope 2003) and Tulum (Miller 1985). Such sites had the power and authority for large-scale construction and habitation. However, typically throughout the region, beginning around 830AD, there was a general wane in construction in the Terminal Classic, particularly in regards to monumental and civic architecture (Coe 2005: 161-162). However, this is not to say that new communities were not established.

2.3 Historical Perceptions of the Maya

Within the past century and a half, cultural understanding and knowledge of Maya culture has grown immensely. Despite the recent focus on the Maya calendar's erroneous prediction of an apocalypse during 2012, much of the longstanding haze of the 'Maya mystique' of one hundred, or even fifty, years ago has lifted. Even though popular media continues to use the ruse of mysterious lost cities buried deep in the jungle, the world now understands so much more about the Maya.

In addition to archaeological evidence, much of what we know about ancient Maya culture comes from inferences originating from first-hand accounts by the Spanish at the time of the conquests in the sixteenth century. Of these, an account given by Bishop Diego De Landa (Pagden 1975) in Izamal and Merida, both on the Yucatan Peninsula of Mexico, is one of the most widely used sources of ethno-historic material on the Maya. Landa was known throughout the Yucatan as a perpetrator of criminal acts against the Maya, which he claimed to be in the name of Spain. Due to the severity of his actions, he was sent back to Spain in 1563 to defend himself in the Spanish court (Pagden 1975: 16). He wrote extensively on the Maya for his defence in court and it is from this work, *Relación De Las Cosas De Yucatán*, written around 1566, that much of the information concerning Colonial Maya religious and social customs derives (Pagden 1975: 17). *Relación De Las Cosas De Yucatán* provides a substantial ethno-historic resource on Maya religion and also supplies the earliest clues for deciphering Maya glyphs, however, a breakthrough in Maya studies that would not occur until roughly four centuries after its writing. However, Landa also burnt thousands of Maya screen-fold books in the 1560s as a means of eradicating Maya belief systems. Had these survived, a considerably more extensive account of Maya life, written by the Maya themselves, would be available to archaeologists and historians, whereas only four known codices now survive (Christenson 2007: 34).

Landa's writing was not the sole ethnohistoric account of the Maya. Other Europeans, such as Bartholome de Las Casas, wrote extensively on the Maya (Casas 1992; Wagner and Parish 1967). While the four surviving Maya codices provide ethnohistoric information, the deciphering of Maya glyphic writing is still in development. In the past thirty years, significant scholarly attention has been directed towards translating key texts. The codices as well as glyphic writing found on stelae (cut stones inscribed with written records), murals, stairways and other objects have all been translated from ancient Maya including two literary sources, the Popul Vuh and the Chilam Balam (Christenson 2007; Edmonson 2010).

The *Popul Vuh*, a Maya religious text written at the time of Spanish contact (Christenson 2007). Through the Popul Vuh, it is known that the Maya believed in an underworld, Xibalba, and that the entrances to this place were located in caves or bodies of water, such as *cenotes* (Healy 2007; McNatt 1996: 81). Many caves throughout Mesoamerica have mural depictions of scenes from Xibalba, and ceremonial artefacts as well as human burials can be found deposited within (Healy 2007; McNatt 1996). A further thread in the Maya belief system was that of the World Tree. This is a concept where the underworld, earth and the sky are represented by a large ceiba tree, which was rooted in the underworld. The trunk was on earth, in the world of the living, and its branches were spread into the upper-world, a world of cosmic deities. This World Tree is depicted in a number of texts, though most famously on the sarcophagus of Lord Pacal, a seventh century ruler of Palenque, in Chiapas Mexico. The ceiba tree (*Ceiba pentandra*) remains an important symbol in Central America, even today it is against the law to cut down this sacred tree in Belize and Guatemala (Atran 1999).

The *Popol Vuh* is not the only source of stories that illuminate Maya cultural beliefs. The same myths are also found depicted in murals and in caves, on architecture, and similar stories are seen in other Mesoamerican cultures. For these reasons, we now know that there were other creation stories, perhaps even older, which did not make it into the *Popol Vuh*, but which still involved many of the same characters and concepts including the Maize God and the Hero Twins, Xibalba, and the World Tree (Coe 1989, 2005: 65).

In the 1800s the lure of the ancient Maya became more prominent in the western world, when John Lloyd Stephens, a writer and diplomat from the United States, and Fredrick Catherwood, an English architect and artist, undertook expeditions together into Central America. The two published accounts of their journeys, which took place between 1839 and 1842, Stephens as the author, and

Catherwood as the illustrator. These books, '*Incidences of Travel in Central America, Chiapas, and the Yucatan, volumes 1 and 2*,' became huge international successes and underwent multiple editions within just a matter of a few years. Stephens and Catherwood were the first to exploit the idea of the Maya mystique with their written accounts and epic drawings of lost cities in the jungle. They were also the first Europeans since Landa to view the cities as having been built by the current occupants of the region, the Maya, rather than by outsiders such as Tartars or Israelites as had been postulated by others (Coe 2005: 25).

In the early twentieth century, the predominant Maya romanticism was the myth of the 'peaceful Maya' and this theory was strengthened as a response in the aftermath of the First World War (Scharer and Traxler 2006). The belief that there was at least a single culture that was more peaceful than the western world was something that was highly desirable during those post-war years (Scharer and Traxler 2006: 58). The idea of the peaceful Maya remained until Maya iconography was further examined, revealing depictions of violence, warfare, captives, and even torture.

Site cores of Classic Maya sites are organized around plaza groups in which the large-scale monumental architecture were built among the smaller structures which also occupied these spaces. During the time when the 'peaceful Maya' concept was prominent, and admittedly even later, it was thought that the large plazas surrounded by high pyramids and other buildings were ceremonial centres, and therefore perhaps not used as often as every day public space (Webster 2006: 130). It was believed that Maya cities in general were sparsely populated, creating an image of large, nearly empty cities with practically untouched centre plazas, used only for religious ceremony. Today this is known to be incorrect. Maya cities were in fact quite densely inhabited. For example, the site of Caracol, during the Classic period, had an estimated population of 115,000 when at the height of its power (Chase *et al*., 2010: 09) and the central courtyards were widely used for many purposes. Through excavations in these large central plazas within the last sixty years, it has become clear that they were foci of activity; they were used as marketplaces and workshops (Ashmore and Sabloff 2002; Capp 2012: 150).

Maya archaeology has grown and developed in the time since Stephens and Catherwood first trekked through the wilds of Central America. The first large scale excavations were undertaken by scholars from the Harvard's Peabody Museum, the Carnegie Institute of Washington, the University of Pennsylvania, and Tulane University (Webster *et al*., 2000: 32-35). Since these early systematic excavations, many other excavations have contributed to a significant body of archaeological research. Moreover, the deciphering of Maya glyphs has facilitated the study of Maya history in the Mayas' own words. This process of deciphering took over four hundred years, but only really gained momentum as recently as the 1980s (Martin and Grube 2008; Houston and Stuart 1992). Due to extensive efforts in epigraphy, archaeology, and other branches of Maya studies, archaeologists and the public alike now know the ancient Maya had writing and numerical systems, a calendar, trade routes, dynastic systems, waged warfare and had a complex religion. This knowledge of the Maya past is ever increasing.

2.4 Maya Political Structure

From the Late Preclassic, (around 300BCE) up through the Terminal Classic (950CE) Maya cities dotted the landscape of Mesoamerica's lowlands in large numbers (See Figure 2.1 for just a few of them). These were city-states which varied both in size and in the extent of their political power (Abrams 1998; Chase and Chase 2001). Maya cites are thought to have been the centres of polities which acted as city-states (defined in Chapter 1). These cities adopted diverse architectural styles depending on location and the period during which they were occupied. The term 'Maya' is believed to have been in reference to an area of the north coast of Honduras by the native people who inhabited the area at the time of the Spanish contact and is likely derived from the place name 'Mayapan' (Graham 2011: 60). Since this time Conquistadors, later explorers, and modern academics have grouped these polities together as a result of their shared basic overall architectural styles, writing systems, and cosmology, however this coherence may be largely anachronistic. The Maya themselves may have perceived the different regions or city-states as distinct. As such, archaeologists now know that Mesoamerica was a completely different landscape in the past than it is today. Whereas this region is today mainly reforested, or converted to farmland, towns and cities, most of the land in Mesoamerica was covered in cities dating as far back as 900BCE, for example the large Preclassic city state of El Mirador in northern Guatemala (Hansen 1990, 2001: 50-65).

Maya cities share a number of characteristic architectural and topographic features. The *bajareque* (wattle and daub) and limestone architecture, large public-civic pyramid structures and the presence of stelae are all dominant features throughout the Maya urban landscape. Stelae are found throughout the Maya region, but are only found in the Classic period (Coe 2005: 162). There is also the presence of Maya glyphic texts, a combined syllabic semasiographic and logographic writing (Van Stone and Coe 2005). This script was not the only writing in Mesoamerica[3] but, as with the Maya style architecture, it was primarily used in the lowlands (Houston *et al.,* 2000), as were *sacbeob*, extensive causeway systems which connected different cities (Chase and Chase 2001).

The largest of all the Maya sites during the Classic Period were Tikal and Calakmul. These two sites have been extensively excavated, surveyed, and researched. Tikal, spans an area of roughly $15km^2$ and comprises about three thousand structures including giant pyramids to small house-mounds along the periphery of the city (Coe 2005: 112). This makes Tikal a large Maya centre in terms of both geographic area and political control, while the majority of cities -- including the three study sites Blue Creek, Nojol Nah, and Xnoha -- are more moderate in size (Barrett and Brown 2008; Guderjan 2007). Finally, whereas most of the population did inhabit cities, we know from excavations such as the extensive surveys completed at Copán in the 1980s (Webster *et al.,* 2005: 32-35) that many people also inhabited more rural settlements. However, due to the thick tropical forest foliage, modern construction, farming, as well as the construction methods of the buildings themselves -- structures were less frequently built with limestone and more with perishable items in these rural areas -- result in ancient Maya rural communities being more difficult to locate and study than their urban counterparts.

[3] The Olmec, Zapotec, and others also used a written script (Houston *et al*., 2000)

2.5.1 Status and Social Structure

Among the myriad of features used to describe a civilization, McAnany and Negron (2010: 142) define civilization as ‘the extreme centralization of power and people into cities, the construction of colossal monumental architecture, and the invention and spread of written script.’ Based on this definition, the Maya were inarguably a civilization, one which had a number of social spheres, from divine kings (known as *k'uhul ajaws* or simply *ajaws*) to commoners. Hereafter the term ‘status,’ will pertain to the societal role(s) and positions which individuals enact throughout their lifetimes. In an economic and Marxist understanding of the term, ‘status’ pertains to the economic standing of an individual within a society (Appadurai 1986: 5; McGuire and Schiffer 1983; Restall 1997). When looking at status in its broadest sense there are a myriad of different aspects. However, when discussing status based on economics, socioeconomic status is seen as an achieved position in material and economic wealth throughout the overall social structure (McGuire and Schiffer 1983: 102; Restall 1997: 93).

Status acts as a key social device. Parker Pearson (1999: 83) argues that ‘Status…involves struggle over scarce resources but is not directly equivalent to class since status groups are communal collectives requiring reproduction or a typical lifestyle whereas economic classes do not necessarily participate in self-defining lifestyles.’ Therefore, status and class intersect where the economically-based experiences and conditions of individuals and populations transform into hierarchical divisions. That is, status pertains to a hierarchical economic system, with many different levels of economic groups.

Economic status differentials among the ancient Maya are viewed as multi-level systems (Palka 1997). Maya polities typically consisted of a ruling elite class, non-ruling upper and middle elite classes and commoners, with various distinctions within each tier, such as the aforementioned *k'uhul ajaw* (divine ruler), *sajal* (non-royal in our western sense of the term but ruled small areas, much like lord or duke), and craftsmen or scribes (Houston and Inomata 2009: 175; Houston and Stuart 1996: 291; Sharer and Golden 2004: 26). Due to these multiple levels of economic status in the Maya world, there were large differences in wealth and distribution of goods across Maya society. In the archaeological record, differences in economic status and class are typically defined through material wealth and access to resources, which is most commonly represented archaeologically both through architecture and material culture. However, as will be discussed further in Chapter 10, this method can prove to be problematic. Within populations, another method used to distinguish levels of social status aside from the material culture is through spatial divisions in settlement topography. Typically, it is believed that the Maya oriented their cities in such a way that the elite and sub-elite were living very close to the epicentres of the cities, while members of lower socioeconomic status inhabited areas on the peripheries of the cities (Guderjan 2007: 67; Pendergast 1992: 63; Williams and White 2006: 141).

2.5.2 Houses, Homes, and Household Theory

The concept of 'house' in archaeological research has never been truly agreed upon, particularly when the concept of 'household' comes into play. 'House' is viewed as a physical entity, the form of a structure; whereas 'Home' is a relative term and is used to describe an individual's place of residence (Ashmore and Wilk 1988: 2-3). 'Households' are a functional unit; they encompass people's day to day life and activities, and act as a tight social unit within which archaeologists and anthropologists can attempt to better our understanding of the larger social order (Ashmore and Wilk 1988: 2-3; Robin 2002). In other words, the house, or rather household, can act as a small social mirror reflecting the larger social composition (Ashmore and Sabloff 2002; Gillespie 2000). People sharing a house create a small-scale social order within that dwelling, with hierarchies and so on, which in some ways replicate the larger social order. Everything from how people create their houses, the layout and the materials used, to what occurs within them, which rooms or areas are used for which specific activities, can inform greatly on the society as a whole. From the house we can infer knowledge on what materials are available and/or preferred, what the social class or status of the people inhabiting the house may be, and so on. The house, as an anthropological concept rather than a structure, can be considered to be almost analogous with terms such as 'kinship,' or 'social group'.

Levi-Strauss (1982: 187; 1983) interpreted households as being transitional elements between the complex and the simple ideals within a society.

Since Willey's (1956) settlement surveys of the 1950s, Mesoamerican archaeology has swelled to include studies in household and settlement archaeology, which has significantly improved our understanding and interpretation of Classic Maya society. The study of households can incorporate demography studies, socio-economic change, division of labour and specialization, gender roles and inequality (Inomata and Stiver 1998: 431). It is now firmly agreed upon by most scholars that there is not a 'universal' idea of a household, but instead that households are culturally defined (Inomata and Stiver 1998: 431).

Within the past few decades, settlement archaeology, both in Mesoamerica and elsewhere, has grown and developed as a discipline as researchers begin to untangle the importance of the house in the archaeological record (Hendon 1996). Netting and Wilk first developed household archaeology in the 1980s (Netting and Wilk 1984 cited in Nelson *et al*., 2002: 128-129). They were the first to identify 'household,' as an archaeological term as the smallest economic unit within a society (Nelson *et al*., 2002: 128-129). Later, Nelson, Wilk and colleagues augmented the original concept, adding the element of culture into the model, thus incorporating cultural aspects such as societal rules and decision making processes (Nelson *et al*., 2002: 128-129; Wilk and Netting 1984). This therefore opens up household archaeology as a gateway for many aspects of archaeology, such as division of labour and gender roles.

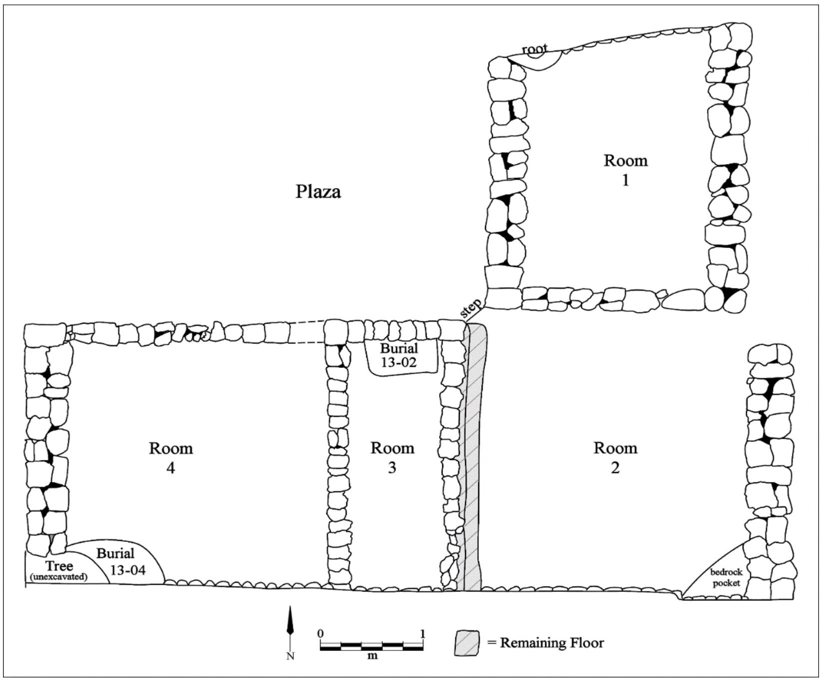

Figure 2.2: Example of Terminal Classic household structure from Xnoha (Structure 67), map by author, 2013.

The majority of Maya houses from the Preclassic into the Terminal Classic were situated around small courtyard or plaza areas and consisted of a number of separate small buildings usually comprising only one or two small rooms though typically no more than four (Figure 2.2). This complex of buildings and open space is known as a house-lot (Robin 2002; Webster *et al.*, 2005 :98). Each of these small structures was used for different activities, such as sleeping, cooking, and workshops (Webster *et al.*, 2005: 98). In addition to courtyards, many Maya homes also had *milpas*, plots of cultivated land, and/or small household gardens adjacent to them (Cruz 1996). These *milpas* are at most not more than 5m^2 in area and are typically used to grow staple items such as maize, beans, and squash, while the household gardens grew other food items, such as avocados, chilli peppers, or cacao (Cruz 1996).

The Maya built their dwellings as structures surrounding a small patio or larger plaza. Cosmologically, directionality played a large role in Maya culture (Ashmore 1991; Ashmore and Sabloff 2002; McAnany 1995: 52). For example the

Maya often linked the direction of north with that of the dead (Ashmore 1991; McAnany 1995: 52). For these reasons placement of various components of the settlement, such as a place to bury the dead, would be considered significant.

2.5.3 Linages and the Concept of 'House'

The idea of ancestors and ancestor veneration is a widespread concept throughout Mesoamerica from at least the Preclassic onward. The Zapotec of central Mexico are believed to be among the first to truly ritualize ancestor veneration, sometime around 1150-800BCE, through the creation of figures to represent the ancestors. According to McAnany (1995: 53) 'in the Maya lowlands, ancestor veneration existed in a variety of social and physical settings: among both non-elite and elite sectors of society and in both domestic ritual and public ritual contexts.' Thus, all sectors of Maya society held this common thread of ancestor veneration and wove it throughout their belief system and daily life.

During the Preclassic and throughout the Classic Period, from at least 1000BCE, many Maya buried their dead underneath the floors of their homes and public buildings (McAnany 1995; Pendergast 1990). At times this would entail creating an entire new floor level, while in other cases a cut in the floor is visible where someone had cut and then re-plastered the floor with limestone. McAnany (1995) argues that in burying their dead within their floors, the Maya were in effect both keeping the deceased within the household unit, and furthering their own ancestral ties to the land, creating legitimacy to the area they lived. Due to this incorporation of the interment of the dead into the physical house structure itself, ancestor veneration was simply a part of daily life (McAnany *et al.*, 1999: 131). With this idea, comes the notion that the same lineage would occupy the same ground for many generations, and this can indeed be seen in the strata of the architectural phases of the structures and as well as in the ceramic phases found in burial contexts.

The construction phases of buildings in the Maya area usually coincided with the burial of an important individual of that particular lineage within the structure, either under the floors, or within limestone benches (Guderjan 2007: 74). However, Gillespie (2000) argues that the way in which archaeologists interpret the Maya concept of 'lineage' should be instead replaced with the concept of 'house.' This idea utilizes 'house' as a social concept, not as the actual physical structures. Gillespie (2000) argues that this shift in vocabulary would be more accurate in terms of the ways in which the Maya comprehended both their social and private space. In this meaning, simply using the term 'house' rather than 'lineage' could lead to an emic understanding of the Maya idea of both family ties and household space.

Gillespie (2000: 469) also argues that 'lineage structure is often a means for ranking individuals, for example, based on genealogical closeness to group founders.' According to Gillespie (2000), this delineation between the concept of 'house' and that of 'lineage' would be beneficial in the overall understanding of how the Maya may have conceptualized their social landscape. As an example, McAnany (1994) posits that one of the causes for burying the dead under houses was that it acts as a way to bind people to the land and as a way to lay claim and legitimacy to an area. That is, if the ancestors are buried in a particular place, then that place truly belongs to those people who occupy it.

2.5.4 Burial Practices and Mortuary Context

Even though most of Mesoamerica practiced cremation, the Maya did not typically cremate their dead (for an exception at Comalcalco see Gomara Gallegos 2003) (McVicker 2012: 215). Rather, the Maya interred the dead in burials of varying styles. Likely owing to preservation conditions, cemetery-like areas are not typically found in the Maya region, at least not in the Western sense (McVicker 2012: 215). Mass cave burials are considered the only known exceptions to this rule (Healy 2007). However, Preclassic and Classic Maya interred their dead within and around residential areas as mentioned above, most commonly in burial benches within their homes or under the floors of household structures (Figure 2.3) (Chase and Chase 1996: 61). As Tiesler (2007: 29) states, 'disposal as part of sequenced construction offerings in palaces, temple areas and, to a lesser degree, in residential compounds, may provide indications on ritual meanings and differential depositional histories.' In any event, the death of an individual, who was interred under a floor of a residential compound, often corresponded with the commencement of a fresh construction phase to that building. At K'axob, a Maya site in northern Belize, there are many instances of Preclassic and Classic construction phases which immediately followed the interment of an individual, and this is apparent due to the tops of the burial chambers being sealed by construction fill alone (McAnany *et al.,* 1999: 130).

Among the Maya, and in Mesoamerica as a whole, it is common to find both primary and secondary interments; the distinction between the two being that a *primary* burial is the first or only place an individual is buried (Smith 1950: 89) and *secondary* burial is the place where human remains are reinterred at some point after death (Prufer and Brady 2005: 272; Welsh 1988: 35). Secondary burials are typically, though not always, smaller in size in terms of the dimensions of the grave. However, it should be recognized that secondary burials do occur in larger contexts, such as tombs, as well as in smaller interments underneath floors (Chase 1994; Healy *et al*., 1998: 270). According to Prufer and Brady (2005: 272) the practice of secondary interments was a custom widely practiced throughout the Classic Maya lowlands. Examples of secondary burials have been recorded at sites spanning the Yucatan, throughout Belize and in lowland Chiapas. While at times it is difficult to discern the differences between a primary and secondary burial, some indicators include skeletal remains which are completely disarticulated and the absence of smaller bones, such as distal phalanges, within the burial assemblage. The latter can only be considered viable evidence as long as excavator error and taphonomy can be ruled out as a cause of the missing skeletal elements.

The practice of reburial after initial decomposition was the topic of a large study completed in 2005, which examined epigraphic evidence for the practice of secondary burial (Eberl and Prager 2005; Tiesler 2007). The study showed that the primary burials, or *muhk-aj* events, typically occurred within ten days after death (Tiesler 2007: 26). The *muhk-aj* was followed by a reburial to a 'final resting place' 100 to 400 days after death, and smaller commemorative events, reducing in number as the years progressed (Tiesler 2007: 26). The practice of reburial seems to occur irrespective of biological sex or status differentials, as males, females, elites and commoners are all found occupying these secondary burials. However, single individual interments remain the most frequently found burial type within the Maya lowlands (Chase and Chase 1996: 61).

Figure 2.3: Example of subfloor burials from Nojol Nah; photo courtesy of the Maya Research Program, 2009. Burial on the left is interred under a newer construction phase than burial on the right.

The earliest known tombs in the Maya area were constructed during the Late Preclassic, 500BCE to roughly 250CE (Lucero 1999: 229; Welsh 1988). By the beginning of the early Classic Period, tombs started to become more elaborate. The Maya began to incorporate higher vaulted chambers and in many instances iconography adorned the walls. Additionally, other forms of interments became more sophisticated during the third and fourth centuries CE (Lucero 1999: 229). Tomb burials have walls and a roof, with room for an individual either to sit up or stand (Smith 1950). Most often tombs are located within elite monumental architecture and can house both primary and secondary interments (Chase and Chase 1996; Lucero 1999).

There are other forms of interment in the Maya region apart from tombs, as I discussed above, and in fact are far more common. These are burials associated with structures such as houses, shrines, civic or ceremonial buildings but there is no tomb construction. The burials can be subfloor interments marked by a cut in the surface of the plaster floor above them but often cannot be detected when sealed by a floor associated with a new construction phase (Brown *et al.*, 2014; Chase and Chase 1998; Smith 1950: 88). Burials were sometimes placed in benches in rooms (Brown et al., 2014). Bench burials are also seen throughout the Maya lowlands and like subfloor burials they may contain single or multiple remains comprising both primary and secondary internments (Geller 2012b: 118-119; Gillespie 2000) (Figure 2.4). Whether placed in benches or under floors, crypts were sometimes constructed which were simply lined graves (Guderjan 2007: 76; Parmington pers. comm. 2014, Smith 1950: 88). Subfloor burials tend to follow a standard structure, without much variation other than marking the grave with a cut, the position of the body, or whether the interment was primary or secondary. While Subfloor burials tend to be quite standard in nature, crypt burials can be a quite different from one another, especially depending on whether the interment is primary or secondary. Some examples of these differences can be seen in Figure 2.5, a clearly defined crypt from a Preclassic burial at Xnoha and Figure 2.6, which shows three secondary Early Classic burial crypts from Structure 4C10 at Nojol Nah. These examples include a crypt in the classic sense, with a border of stones encircling a flexed burial (Figure 2.5) and small box-like crypts also of stone, which contain the remains of secondary burials (Figure 2.6). All of these burial types are found across a variety of contexts, in all social levels and structure types (Chase 1994; Smith 1950).

Figure 2.4: Eastern Bench Burial at Structure 4C10, Nojol Nah; photo courtesy of the Maya Research Program.

Figure 2.5: Burial crypt from Xnoha (burial XO-14-14), note the stone wall lining the burial and the cylinder jade bead by the long bones (arrow); photo by the author.

Figure 2.6: Three subfloor secondary crypt burials at Structure 4C10, Nojol Nah (foreground to back: burials NN-35, NN-36, and NN-37); photo courtesy of the Maya Research Program.

There are various types of associated grave goods in Maya burials. A detailed account of grave goods in the Maya region is beyond the scope of this thesis; however, mentioned here is a brief contextualization. Most commonly found -- due to preservation -- are ceramic vessels, typically placed over the face or legs of the deceased individual, jadeite[4] celts, beads of shell or stone, and *Spondylus* shells. Often these burial goods have associations with water or aquatic environments, and may suggest the association of watery places with the underworld. As McAnany, Storey, and Lockard (1999: 129) state, 'although burial customs are no longer assumed to mirror directly social reality and status grades within a society, they do reflect even if in a somewhat encrypted form, the range of social differentiation and degree of ritual elaboration.' This is apparent when examining the vast differences in Maya burials, from the structure of the burial, to the associated grave goods and physical orientation of the deceased themselves.

2.5 Maya Diet

Maya diet relied heavily on three main substances: maize (*Zea mays*), beans (*Phaseolus vulgaris*), and squash (*Cucurbita pepo*), with maize being the primary food source throughout much of Mesoamerica (Fitzsimmons 2009: 23; Lentz 1999; Wright 2004: 202; Wright 2006: 89; Wright and Chew 1998: 926). These three food groups remain major components of diet in Central America. Today in Central America, beans are typically eaten once they have been mashed or boiled and are the most common filling of tamales (Wright 2006: 90). Beans were the largest source of protein in ancient Maya diet as well, comprising as much as 30% of total dietary protein (Wright 2006: 89).

Other sources of protein included (though was not limited to): whitetail deer (*Odocoileus virginianus*), gibnut (*Agouti* or *Cuniculus paca*), bush rabbit (*Dasyprocta punctate*), tapir (*Tapirus bairdii*), white lipped peccary (*Tayassu pecari*), and varieties of freshwater and marine fish, snail, and turtle species. However, maize was the principal food source in Mesoamerica.

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[4] Commonly referred to as 'jade' jadite is only sourced in two areas of the Maya region, and is not true jade, which is not found naturally in the Americas but instead is sourced in Asia.

The term 'maize' comes from an Arawak term augmented from the Spanish (Wright 2006: 89). Fitzsimmons (2009: 23) states that 'maize was an integral part of life in the [Maya] lowlands.' Indeed, maize was present at every Maya site where archaeobotanical work has been undertaken (Lentz 1999). Even today, Maya diet continues to be heavily maize-based. Maize can provide up to about 70% of total modern Maya diet (Wright 2006: 89). Despite substantial changes in Maya diet through time with the arrival of the Spanish (for example the introduction of citrus and European domesticated animals such as cows and chickens) there is still some continuity of Maya diet through time (Wright 2006: 89).

Maize processing practices have been studied at a number of sites across the region. After harvest, maize would be ground and treated with lime, a process termed '*Nixtanamal*' by the Mixtecs[5] (Cheetham 2010: 346). Aside from softening the maize, this would improve the nutritional content, because the treatment of lime not only supplies the diet with additional calcium, it also increases accessibility to niacin (vitamin B) and a number of amino acids (Katz *et al*., 1974). The results of studies into maize processing show that females typically did most of the maize grinding (Wanner 2007: 262). Maize reliance varied across the region however; the Petén for example had a higher prevalence of maize harvesting and consumption than Belize and coastal sites (Wright 2004: 202). This is due to the coastal sites having greater variety of alternative resources including marine based foods. Variations in skeletal health indicators at Maya sites have been explained by differences in the representation of maize in the diet. At the site of Cuello in northern Belize, porotic hyperostosis rates in the skeletal population were 'lower than average' and Wright and Chew (1998: 927) suggest this perhaps has to do with less maize consumption and greater variety in diet at that site. The highest concentration of maize consumption compared to other Maya sites was found at Copán (Webster *et al*., 2000: 133). Closer to the northern Three Rivers Region, at the Coastal Plain site of Lamanai, Belize, there was a decline in caries

[5] Later, this was 'Hispanicized' to 'nixtamal' (Cheetham 2010: 346).

through time which has been associated with a parallel decline in the production and consumption of maize (White 1997: 171-180).

The question of variability in diet as it relates to Classic Maya status has become a topic of discussion in recent years (Lentz 1991; Lund 2003; Scherer *et al*., 2007; Seidemann and McKillop 2007; White and Schwartz 1989; White 1999; White *et al*., 1993; 2001; Whittington 1999; Whittington and Reed 1997; Williams *et al*., 2009; Wright 2006; Wright and White 1996). The difference in diet between elites and commoners has been addressed primarily through studies involving stable isotope analysis. A stable isotope analysis on a large skeletal population from Caracol was undertaken in an attempt to address some of the ambiguity in terms of determining social economic status (Chase and Chase 2004: 122). The goal was to determine whether the elites had better quality diets than non-elites. Through their analysis, it was revealed that rather than one diet for the site as a whole, there were three distinct diets throughout the city (Chase and Chase 2004: 122). It was then inferred that these distinctions were due to differentials in social status (Chase and Chase 2004: 122). Since the most balanced diet of the three was one high in both maize and protein and indicators of such a diet was found in skeletal remains located within the site core of the site, it was inferred that there was a difference in diet based on social status (Chase and Chase 2004).

A stable isotopic analysis of the Classic period skeletal population of Piedras Negras, Guatemala showed that difference in diet between individuals of higher status and those belonging to the commoner classes 'approached significance', although the results may not be significant because of the temporal variability of diet and small sample size (Scherer *et al*., 2007: 97-98). This was also true when comparing porotic hyperostosis and dental carries (Scherer *et al*., 2007: 97). It can thus be inferred that the whole population at Piedras Negras during the Classic period may have had similar access to types and quantities of protein despite economic status or class differences (Scherer *et al*., 2007: 98). The cases presented here, both at Caracol and Piedras Negras, achieved contrasting outcomes. Region and timeframe play large roles agricultural abundance as well as access to goods and trade, and these separate outcomes are most likely indications of the variability in dietary patterns throughout Mesoamerica.

Chapter Three

Osteology and Health Indicators

Osteology, the study of bone, is intrinsic to archaeology and the study of past populations. First, this chapter briefly discusses the chemistry of bone, as well as the theoretical perspectives of the practice of osteology, because it is essential to have an understanding of the structure of osseous and dental tissues so that the discussion of health indicators and their effects on bone can be fully understood. Second, there are inherent problems and issues when studying disease in archaeological skeletal assemblages and this chapter will highlight those concerns. These problems include the vagaries of preservation issues, whether the skeletal sample reflects the living population, and the issues surrounding the differentiation of pathological lesions from the effects of taphonomic processes. Third, the chapter provides a review of osteological investigation in the Maya region. Finally, an overview of the health indicators examined in the current study is provided. This will include health indicators which affect skeletal as well as dental remains.

3.1 Bone Structure

Although the northern Three Rivers Region study focuses on macroscopic elements to evaluate and analyse the skeletal assemblages discussed, a brief review of bone micromorphology and structure is presented here, as an understanding of bone at the microscopic level is central to understanding pathological changes to bone at the macroscopic level. Bone is a composite material, composed of both mineral and organic content, in particular calcium phosphate and protein collagen, and has two main structural components: cortical and trabecular bone. While at the cellular level these two types are the same, the differences in thickness and porosity separate the two in terms of overall gross bone structure (White and Folkens 2012: 32). Cortical bone is the outer layer of bone, whereas the trabecular bone is the interior of bone, and consists of haversian canals that supply blood close to the surface of the bone. There are also two main types of bone cells, osteoblasts, which aid in the formation of bone, and osteoclasts, which resorb bone, this process is bone remodelling. If a disease becomes severe enough to affect bone, the normal process of remodelling provided by the osteoblasts and osteoclasts is disrupted and there is an excess of the formation/inflammation or degradation of the bone, thus presenting changes both at the micro- and macroscopic levels (Waldron 2009: 19).

Living bone exists in a constant state of remodelling, of which there are three distinct parts: activation, resorption, and formation (Crowder and Stout 2012: 2-5; Waldron 2009). Activation is initiated as a response by osteoclasts to various biomechanical factors. This is followed by remodelling, and finally formation, during which osteoblasts secrete osteoid, which becomes mineralized by calcium (Crowder and Stout 2012: 2-5; Waldron 2009). Diseases that are severe or long lasting enough to affect bone disrupt the normal process of bone remodelling, thus bone is formed or lost in excess.

In osteology, direct diagnosis can be difficult, as complete skeletons are rare in the archaeological record and many skeletal elements could be missing. This is particularly true in regions of poor preservation. Another difficulty is that paleopathological lesions only comprise one of three altered bone states: blastic, lytic, or mixed blastic and lytic lesions. As a general rule, there are many aspects of paleopathology which are limiting, as most diseases do not affect bone, and in many instances those that can affect bone kill their host before the effect can occur. There are major abnormalities which can occur in bone and therefore aid in the diagnosis of paleopathology: abnormal formation, alteration in shape such as bowing, and dissolution of bone (Ortner 2011).

3.2 Methods and Sampling

There are two methodological problems when interpreting osteological data. The first is a concern with how representative the skeletal population is in relation of the population as a whole, and the second is how representative skeletal and dental health indicators are in regards to skeletal remains (Bush and Zvelebil 1991: 7; Wood *et al*., 1992). Since few diseases affect bone and dentition, or are severe or persistent enough to affect bone, there is the question of how much can actually be interpreted or inferred about the health of past populations. Furthermore, many indicators are not pathognomic and can be indicative of various different diseases. For example, periosteal reactions have numerous aetiologies and many factors can result in the same response by the body; the fact that periosteal reactions are present on a bone –unless paired with other symptoms -- is simply an indicator that the individual suffered some form of localised insult to the skeleton.

In the process of analysing most skeletal remains, the individuals are placed into one of two categories, healthy or unhealthy, based on the appearance, or otherwise, of pathological skeletal health indicators (Dewitte and Stojanowski 2015; Wood *et al*., 1992). This binary system is one which is inherently flawed, as not all diseases affect the skeleton, and those that do must be chronic and severe before they manifest on the skeleton. Individuals who died prior to the manifestation of their disease on the skeleton would not be identifiable by osteologists, and cannot be differentiated from individuals who were ostensibly healthy (Brown and Brown 2011; Wood *et al*., 1992). Also to be considered, whereas a set of skeletal remains might exhibit evidence of a particular disease, the individual may have died from an entirely unrelated cause(s). Even once the above factors are considered, there is still the issue of whether the skeletal sample is representative of the population. Only with consistent and methodical analysis can this last issue be dealt with in order to minimize misrepresentation. As Dewitte and Stojanowski (2015: 10) aptly state with regards to the osteological paradox, 'we [osteologists] are attempting to reconstruct the lines and health conditions of people in past populations by using inherently biased samples of dead individuals.' Along a similar line, Waldron (1994: 12) argues that four variables impact skeletal populations: the percentage of the population buried at the site being excavated, the percentage of the remains that survive to excavation, the proportion of the remains discovered, and finally the total recovered. These are important factors to consider, as nearly no excavation site will result in the exhumation of an entire population. Despite these issues, osteological studies of health and disease are relevant and continue to shape our understanding of past populations. Osteological studies are unique in that the physical remains of past populations are being studied.

Health can be viewed through many different lenses; Hillson (1991) lists incidences of infectious diseases, social conditions which affect mental and/or physical wellness, and dietary status of a population as various ways of how health can be viewed in populations. The World Health Organization (WHO) defines health as 'a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity' (Official Records of the World Health Organization, no. 2: 100). As Bush (1991: 11) explains, 'Ecological definitions of health emphasize the dynamic nature of the condition, and in particular the ability of the individual to recover from insult.' Disease too, takes on a multitude of forms, and the absence of good health is only the first step in diagnosis. What follows is a discussion of the taphonomic process as it relates to skeletal remains and health indicators, followed by a section on the descriptors of the various health indicators seen when analyzing the recovered skeletal populations of the three study sites and contemporaneous smaller sites within this corner of northwestern Belize.

3.3 The Taphonomic Processes

At times, it can be difficult to determine whether a supposed macroscopic trauma, lesion, or other health indicator is pathological or instead simply remnant of the taphonomic process. The term itself, 'taphonomic,' was coined by palaeontologist Ivan Efremov in 1940, as a means to ascribe a name to the process involved in the decomposition and eventual fossilization of organic remains (Gifford 1981; Tiesler *et al*., 2010: 365-366). The term is derived from the Greek '*taphos*' meaning tomb or burial, and '*nomos*' meaning law or system (Gifford 1981; Micozzi 1991: 3). Tiesler and colleagues (2010: 366) described the attributes of this process as follows: 'According to human taphonomic criteria, the changes occurring during individual body decomposition can be viewed as a sequence of interactions between the process of deterioration and preservation, driving by intrinsic (bodily) and extrinsic (environmental) agents, the latter being of either natural or cultural origin.' When examining human remains within an archaeological context, these extrinsic factors are the elements recorded and studied.

The ways in which the extrinsic taphonomic process can affect bone are subdivided into two separate types: abiotic and biotic (Nawrocki 1995: 51). Abiotic factors are purely environmental, such as temperature, water or sun exposure, burial depth or pH levels in the soil (Nawrocki 1995: 52). Biotic factors are those that involve active organisms, in particular microorganisms, but also include carnivore scavenging, insect activity, and tree-root damage. It is important to be able to recognize and correctly interpret both abiotic and biotic processes so as not to confuse them with a paleopathological condition. At times however, distinguishing abiotic from biotic factors can be quite difficult, particularly when dealing with poorly preserved or fragmentary remains (Kemkes-Grottenthaler 2002: 65; Roberts and Connel 2004: 36; Waldron 2009).

3.3.1 Preservation of Human Remains in Mesoamerica

In the Maya region preservation of human skeletal remains is relatively poor (Geller 2012: 258; Healy 2007: 262; McAnany *et al*., 1999: 132; Scherer *et al*., 2007: 90; Serafin *et al*., 2014: 142; Tiesler 2007: 16; Wanner 2007: 254; Webster 1997: 8; Webster *et al*., 2000: 123). Contributing largely to this are the humid conditions of the tropics, as well as the karst soils of the Yucatan (Webster 1997). The petrocalcic horizon of the surface soil is only about 1cm thick, under which is carbonate rock known locally as sascab (Beach 1998: 765). Sascab is porous and water retentive, and slightly acidic rainfall in the area ensures that osteological remains often do not survive (Beach 1998: 765). Skeletons in well-constructed, protected burials, belonging to elite and sub-elite social spheres as a rule, are the best preserved (Webster 1997: 8). Many skeletal remains found in the Maya area are exceedingly fragmentary, or at times simply represented by discolorations in the soil (Webster 1997: 8). The skeletal sample in my study was recovered from varied contexts within the study sites, and therefore preservation also varies, although particular communities such as the Nojol Nah sub-elite, are well represented in the osteological record.

3.4 A History of the Study of Osteology in the Maya Area

Osteological studies in the Maya region have a relatively short history compared to other regions (Marcus 2003: 71-72). This is in part because of the relatively low number of skeletal collections from the area reflecting the issues of preservation previously discussed, but also due to bias within early studies -- which tended to focus on cultural body modifications -- as well as the low priority in early Maya excavations of the importance of skeletal remains within broader archaeological context (Spence and White 2009: 233). Most early skeletal studies in the Maya region focused on cranial modifications and dental filing and inlays (Caceres 1938, Dingwall 1931 both cited in Spencer and White 2009: 234). This early work fostered an interest in the scientific community for Maya remains; however, it was not until the 1940s (Hooton 1940) and later (Haviland 1967; Saul 1972) that ancient Maya skeletons were seen as a source of information beyond the cultural practices described.

A second focus for early osteological studies was the role of disease in the Maya collapse. In the 1920s Spinden (1928) introduced the idea of epidemic disease as a cause for the Maya collapse (Spinden 1928; Wright and White 1996: 152). Later Hooton (1940) proposed that nutritional issues such as vitamin deficiency may have contributed to the collapse (for further information see section 3.7 of this chapter [Hooton 1940; Wright and White 1996: 152]). Hooton's work at Chichen Itza, in the Yucatan Peninsula of Mexico, focused on indicators of anaemia in skeletal remains from the *cenote*, prior to which he also undertook research of the remains from the Pecos Pueblo in the North American Southwest (Hooton 1930). As Waldron (1994: 3) posited, what truly made Hooton's work important in the study of paleopathology was that he treated his skeletal samples as populations, not just individual cases, and incorporated population statistics into his study. Thus, Hooton was a pioneer not only in Maya osteology but also more inclusively, in the study of paleopathology and health indicators. Hooton incorporated a wider view of the past into his study, going from the individual to the population.

It was not until the late 1960s and early 1970s that osteology of the Maya region began to take its present form. We are indebted largely to the works of

Haviland (1967) and Saul (1972), both of whom created the first true systematic osteological studies on the Maya realm. Both Haviland and Saul examined the role of nutritional disease in the so-called 'collapse' of the Maya civilization. Haviland analysed the skeletal collection at Tikal, and Saul the skeletal collection at Alter de Sacrificios (Haviland 1967; Saul 1972). With these two osteological reports, an inclusive, systematic and scientific approach to Maya osteology was established and followed (Cucina and Tiesler 2005: 31-37; Wright and White 1996: 152).

Since these early studies, Maya osteological research has grown and matured, with osteologists studying the Maya at the population (Scherer *et al*. 2007; Serafin 2001; McAnany *et al*., 1999; Wright 2006) as well as individual level (Geller 2012; Mizoguchi and Nakamura 2006; Nystrom and Buikstra 2005; Tiesler and Cucina 2012; Wright 2005). Research has focused on studying aspects of Maya biology and culture through the skeleton including the recording of stature (Bleuze 2007; Couoh 2013; Masur 2009), growth and development (Cucina 2011; Wright and Vasquez 2003) health indicators (Chase 1994; Lund 2003; Marquez *et al*. 2002; Marquez and Storey 2007; Scherer *et al*. 2007; Serafin *et al*., 1989; Storey 1998; Tiesler and Cucina 2012; Wright and Chew 1998; Wright 2006; Wright and White 1996), dentition (Cucina and Tiesler 2003; Mickleburgh and Pagan-Jimenez 2012; Williams and White 2006, Wright 2006; Veriani *et al*., 2011), sex and gender differences (Cucina *et al*., 2003; Storey 1998; Leatherman 1998; Wright 2006) and stable isotope evidence for both migration/place of origin (Price *et al*., 2009; Miller 2015; Wright 2005), and diet (Scherer *et al*., 2007; White and Schwartz 1989; White *et al*., 2001; Whittington and Reed 1997; Williams *et al*., 2009; Wright 2006).

Osteological analysis of the Maya world is growing, and Webster (1997: 8) argues that Mayanists are becoming more aware of the potential for information provided by skeletal remains. Cucina and Tiesler (2005: 30) state that typical Maya research continues to use human skeletal remains as 'peripheral evidence' and that a number of archaeologists working in the Maya region 'still appear to be unaware of the great potential that skeletal data sets have in cultural reconstruction.' There are still many gaps in osteological research in the Maya area. This study fills the gap in information in the northern Three Rivers Region, as prior to this research a systematic osteological study of the region had not been completed.

3.5 Health Indicators

What follows in this section is an overview of some of the most commonly identified health indicators in the osteological record in Mesoamerica: dental pathologies, osteoarthritis, porotic hyperostosis, cribra orbitalia, and osteomyelitis. While these are by no means the only pathological lesions observed, they are the most common within the Maya region. Skeletal trauma will also be discussed within this section.

Compared to Old World disease patterns, pre-Columbian America is considered to be largely free of many commonly recognisable diseases (Storey 1992: 43). That is not to say that there were not endemic or diseases which affected the Americas just that rates and types of diseases differ greatly from their Old World counterparts. The types of diseases that would have been prevalent prior to Spanish contact include respiratory infections, tropical fevers, non-venereal syphilis and tuberculosis (Storey 1992: 43). One possible reason why there may not have been as many infections in the New World is that the Americas, by and large, did not have domesticated herd or pack animals which would have lent themselves easily to the spread of disease (McNeill 1970: 176-180; Storey 1992: 43). In Mesoamerica in particular this could very well be the case, as dogs and turkeys were the only domesticated animals in the region (Storey 1992: 44). When studying health indicators of skeletal remains, presence or absence of pathology becomes a paramount source of information.

3.5.1 Dental Pathologies

Tooth defects and dental pathologies are used both in archaeological and anthropological research as indicators of diet and health because many diseases affect teeth, and much information on individual health can be derived from their study including information on an individual's or population's health and diet, and when used for strontium isotopic analysis can also lend insight into where an individual grew up. Finally, there is a relative abundance of dentitions within the archaeological record, as enamel is the toughest element of the human skeleton. Therefore, even if the skeleton no longer exists, in regions where there is poor preservation, dentition can not only survive the taphonomic process but also creates a store of information on which osteologists can rely.

3.5.1a Dental Caries

Dental caries, or tooth decay, are categorised as the demineralization of the dental enamel and dentine, which creates a cavity in the crown or root. There are two main types of caries, based on the location of where they form on the tooth: occlusal and interproximal caries (Hillson 2005). Occlusal caries form on the occlusal surface, while contact caries form in the contact where teeth meet (Hillson 2005). Caries are formed by the action of organic acids created when carbohydrates are fermented by bacteria.

Caries are some of the most common pathologies observed in human remains and are especially common amongst populations whose diets are rich in maize (*Zea mays*) (Hillson 1996). This is due to the high sucrose and heavy plaque build-up associated with diets high in maize. Sucrose and plaque are the result of organic acids created when carbohydrates are fermented by bacteria. While sugars, such as the sucrose found in maize, are particularly cariogenic, proteins can be more likely to cause plaque (Hillson 1996). Diets heavy in proteins, calcium and phosphorous can aid in the development of plaque, but the fermentation of carbohydrates such as sucrose is critical in the progress of dental caries (Hillson 1996). At Copán, Cucina and Tiesler (2003) found that in the adult samples, individuals who belonged to the ruling and non-ruling elite were less affected by dental caries than those individuals of lower status. This suggests that diet of the Copán elite classes was different, possibly including less carbohydrates, such as maize, and greater proportion of other foods less linked to tooth decay, such as animal protein (Cucina and Tiesler 2003: 2). A correlation between status and diet has also been found at Lamanai where there was a difference in the rates of caries between biological sexes (White 1997: 171-180). Among the elite status individuals, females had a higher occurrence of caries (Cucina and Tiesler 2003: 6-8; White 1997: 171-180). This could indicate that upper class males received the highest levels of protein in their diets with females consuming more maize (Cucina and Tiesler 2003: 6-8).

3.5.1b Dental Calculus

Dental calculus is mineralized plaque which forms on the external surfaces of teeth. There are many interrelated causes of the formation of dental calculus and all too often in the anthropological literature the causality is simplified (Lieverse 1999: 219). Whereas dental caries are caused by carbohydrates, calculus is primarily caused by proteins. Thus, the presence or absence of either caries or calculus is excellent indication of protein-heavy diets versus diets heavy in carbohydrates (Hillson 1979).

There are two types of dental calculus, supra- and subgingival, which are categorized due to their composition as well as their loci within the dental arcade (Hillson 1996; Lieverse 1999; Mickleburgh and Pagan-Jimenez 2012). Mineralization of supra-and subgingival calculus is varied, with subgingival being far more heavily mineralized than supragingival (Hillson 1996). Whereas supragingival calculus can occur both in teeth that are healthy and have periodontal disease, subgingival calculus occurs only in dentitions suffering from periodontal disease. This is because these dentitions have roots which are exposed long enough for plaque to form (Lieverse 1999). As with dental caries, while diet plays a role in the development of calculus, it is not the sole cause. The formation process of calculus begins when food particles become trapped between the teeth or between the teeth and the gum line, and are therefore protected against the natural chemical breakdown by the saliva, creating plaque. Bacteria adhere to the pellicle (an organic layer over the surface of the tooth crown, created by saliva and gingival crevice fluid), and metabolize food passing through the mouth (Hillson 1996). Calcium, phosphate, and alkalinity levels in the saliva, which can all be directly correlated with diet, all factor into the formation of plaque, through rates of fermentation and balancing pH levels (Hillson 1996; Williams and White 2006). Finally, some cultural practices such as diet, general oral hygiene, using teeth as tools, or chewing of cacao can either induce or inhibit the formation of plaque (Lieverse 1999; Williams and White 2006). Varying degrees of dental calculus are commonly reported among skeletal populations of the ancient Maya, and the frequency is often regarded as a consequence of both status and diet, with less abrasive diet among the Maya elite than among individuals of lower economic status (Cucina and Tiesler 2003; Seidemann and McKillop 2007).

3.5.1c Periodontal Disease

Periodontal disease, or periodontitis, is caused by bacterial infection which results in the inflammation of the gum margins around a tooth. Both the soft tissue and, in severe and chronic cases, the underlying bone can be affected. Soft tissue becomes irritated and inflamed, while the bone along the crest of the alveolar becomes eroded and remodelled. Periodontal disease is recognizable as the recession of the alveolar bone of the jaws with small porosities present on the bone. While often observed with cases of calculus, periodontal disease and calculus are not directly linked (Ogden 2008: 289). In severe cases of periodontal disease, premature tooth loss can occur due to the destruction of the alveoli. Cases of periodontitis have also recently been linked to diet and poor oral health (Lieverse 1999; Ogden 2008).

3.5.1.d Antemortem Tooth Loss (AMTL)

Tooth loss can occur in extreme cases of periodontal disease, when the gingivitis reaches the alveolar bone under the gum line, which causes the gum line to retract so much so that the result is the loss of the tooth. Alternatively, if a cavity persists and worsens, it can result in penetrating the pulp chamber of the tooth. Once this occurs, bacteria can enter the pulp chamber and cause inflammation, resulting in the eventual loss of the tooth.

3.5.1e Linear Enamel Hypoplasia (LEH)

Linear Enamel Hypoplasia (LEH) is a particular form of enamel hypoplasia, and is the disruption of dental development resulting in bands of depressed and thin enamel. It is studied as an indicator of poor overall heath due to metabolic stress while the tooth is developing. Enamel Hypoplasia (EH) has been studied since the early eighteenth century, and is categorized into four distinct types: missing enamel, vertical grooves, pits, and finally horizontal grooves, the last of which is Linear Enamel Hypoplasia (LEH) (Hillson 1996; Maclellan 2011: 42). The formation of tooth enamel is created in layers, through the work of ameloblast cells. These cells work from the crown cusp of the tooth towards the root, and leave a matrix of proteins which then undergo the process of calcification. However, if there are any disturbances which disrupt the ameloblast cells during this process, the excretion of enamel is altered. If the cells do not recover quickly, then they will temporarily not form any further enamel, resulting in enamel hypoplasia (Maclellan 2011: 42, Turner and Armelagos 2012: 74).

LEH can occur as a result of a variety of different diseases and is often caused by the interaction between both disease and malnutrition (Wright and White 1996: 164). LEH occurs in childhood, and is caused by disruption of the development of the tooth. Unlike bone, enamel does not undergo remodelling during life; enamel is a record of the time when it was formed, approximately during the first twelve years of life. Thus, LEH can act as an indicator of the overall health of an individual's childhood (Ogden 2008: 284). Indeed, the study of enamel hypoplasia remains the most frequently used method of determining childhood health in the archaeological record (Wright and Yoder (2003: 53). While information regarding skeletal health in childhood is often lost due to bone remodelling, LEH is a permanent mark on the dentition (Figure 3.1).

Figure 3.1: LEH on central incisor of BC-SH-3.

6.5.2 Osteoarthritis and Degenerative Joint Diseases (DJD)

Degenerative joint diseases (DJD) are those in which the joint becomes inflamed, resulting in reaction in both soft tissue and bone. The most common type of degenerative joint disease is osteoarthritis (OA). Osteoarthritis is a category of degenerative joint disease that affects load-bearing synovial joints such as the hip and knee joints, and the synovial cartilaginous joints of the vertebral column, and occurs due to the gradual degradation of the articular cartilage; however DJD can also affect non-synovial joints (Aufderheide and Rodriguez-Martin 1998: 93-96; Bridges 1992: 67; Jurmain and Kilgore 1995: 444; Rogers and Waldron 1989: 624). Degenerative joint diseases come in many forms: a) bone porosity which at times can connect to subchronal cysts; b) eburnation, the onset of smooth dense bone where the cartilage has been obliterated through wear and thus the underlying bone is revealed; and c) osteophytes, bony spurs which occur when the cartilage surrounding joints degenerates (Cox and Mays 2000; Rogers and Waldron 1989). Therefore, the total bone mass is reduced but the mineralization rate of the bone stays the same. Degenerative Joint Disease typically occurs in older adults; the majority of people over the age of 60 years old will exhibit osteoarthritis in some form, and individuals can start showing the signs of osteoarthritis earlier (in their late 20s or early 30s). Repetitive and consistent minor trauma causes degenerative changes to the bone; typically this occurs at particular sites on the skeleton, load bearing joints, such as the vertebral column, knee and hip joints, and the bones of the hands and feet.

3.5.3 Schmorl's Nodes

Schmorl's nodes are indentations that can occur on the inferior or superior surface of the vertebral body. They are most commonly found on the thoracic and lumbar vertebrae and can be associated with severe cases of osteoarthritis, or caused by axial compression due to trauma or chronic compression. A study by Dar and colleagues (2010: 670) shows that Schmorl's nodes are likely to develop independently of osteoporosis and osteoarthritis, but that they often are considered to be to be the first indication of these diseases, or of trauma to the vertebral column (Dar *et al*., 2010: 670). They suggested that Schmorl's nodes begin formation in adolescence. The aetiology is that the movement -- any repetitive movement though specifically twisting motions -- during this phase of skeletal development will create a large amount of strain on the endplate. Following this pressure or strain on the endplate, fissures begin to develop, and this creates a herniation of the intervertebral disk. Once blood vessels reach those fissures they swell and this begins the destruction of the vertebral body. If this continues, a cavity is created and an osseous barrier is then formed to surround the cavity and halts the process of corrosion (Dar *et al*., 2010).

3.5.4 Porotic Hyperostosis and Cribra Orbitalia

Porotic hyperostosis and cribra orbitalia are lesions found in the cranial vault and orbital roof respectively. Both result in a thinning of the outer layer of bone as well as an increase in the diploe bone, leading to an expanded and porous appearance with the end result being that the outer table of bone is left completely destroyed. In healthy individuals the production rate of red blood cells equals that to which the cells are destroyed (Walker *et al*., 2009: 110). Anaemia however, is the reduction of haemoglobin levels and is found when the red blood cell count is below average as a result of increased haemolysis (Roberts and Manchester 1997: 166; Walker *et al*. 2009: 111). Anaemia can also be caused by significant blood loss. Indeed, the term ‘anaemia,’ literally means ‘without blood’ (Walker *et al*., 2009: 110). The sites of red blood cell production changes during development; in childhood the main production sites are the diploe in the cranial vault as well as the medullary cavities in the long bones (Walker *et al*., 2009: 110). Mature marrow gradually replaces the hemopoietic marrow as an individual ages, and as such porotic hyperostosis does not occur into adulthood (Wright and White 1996: 157). However, remodelled porotic hyperostosis lesions from childhood anaemia can still be visible on adult skeletons. Individuals seen with active lesions are immatures, most commonly under the age of five at the time of death (Larsen 2003: 32; Wright and White 1996: 157).

Healthy red blood cells require a diet with sufficient iron. Even though iron is found in many food sources, the iron in plants is more difficult to absorb and many plants, including maize, can actually inhibit the absorption of iron (Roberts and Manchester 1997: 166). The reliance on maize in the Maya diet has therefore resulted in much discussion of its supposed involvement in iron deficiency anaemia. Maize contains tannins (polyphenols) which act as inhibitors to iron absorption (Holland and O’Brian 1997: 184). Maize itself contains only trace elements of iron, and the iron which *is* present in maize is not usable nutritionally due to the effect of phytates (phytic acid) (Roberts and Manchester 1997; Whitaker 2011). However, the lime treatment process discussed in chapter 2 (section 2.5) does partly combat this issue. Typically, iron deficiency anaemia is seen as having additional factors that affect the general severity of the condition. Examples include the overall iron content in the individual’s diet, the duration of anaemic stress, the individual’s own stored iron reserves, and individual predisposition to anaemia such as a low birth weight (Larsen 2003: 29).

There is no agreement among biological anthropologists regarding the relationship between porotic hyperostosis and dietary iron deficiency resulting from maize consumption. Indeed Rothschild (2012) argues that the consumption of maize is not a ‘dietary implication,’ of porotic hyperostosis as some might believe, and that the very idea that iron deficiency is the cause of porotic hyperostosis is a myth. In terms of the relationship between anaemia and infection, Wright and Yoder (2003: 55) state that while the exact relationship remains somewhat obscure, perhaps it is more informative to conclude that rather than being the primary cause of dietary anaemia, infection could simply be a contributor. However, it has also been argued that anaemia is unlikely to develop solely though general malnutrition; rather, that while poor nutrition can be a large factor, it must be combined with parasitic infection (Wapler *et al*., 2004: 337). Parasites can also act on anaemia, as parasitism can affect the metabolism of iron through inhibiting iron absorption or even through direct loss of blood (Stuart-Macadam 1991: 105). Storey (1998: 135) states that both porotic hyperostosis and cribra orbitalia are caused by high levels of anaemia experienced in childhood and that the presence of either symptom is linked to high pathogen levels as a result of poor hygiene.

Cribra orbitalia is recognized by the appearance of lesions along the orbital roof, and almost without exception presents bilaterally (Steinbock 1976: 239). Cribra orbitalia is delineated into three categories depending on overall appearance: porotic, cribotic, and trabecular. In the first case, porotic, the lesions are small and fine, and dispersed. With cribrotic cribra orbitalia, the lesions are larger and greater in number, until finally the lesions advance to the trabecular stage, when the lesions have spread together creating large holes with many different areas of activity along the orbital roof of the frontal bone (Steinbock 1976: 241). These coalescing pores are representative of the most severe type of cribra orbitalia. In the osteological record, cases where the individual lived through the cribra orbitalia can be observed in lesions which exhibit various stages of remodelling.

The question of the relatedness of porotic hyperostosis to cribra orbitalia has been raised many times in recent decades (Holland and O'Brian 1997; Walker *et al*., 2009; Wright and White 1996). One leading argument is that cribra orbitalia is an 'initial reaction' to anaemic stresses commonly found in younger children, and that only with continued dietary stress does porotic hyperostosis occur (Wright and White 1996: 157). Others (Walker *et al*., 2009: 109) reason that while cribra orbitalia is at times synonymous with porotic hyperostosis, there is both clinical and paleopathological evidence that they have different aetiologies, and are therefore separate from one another. For the northern Three Rivers Region study, while discussed in tandem, the two symptoms are dealt with separately.

'Porotic hyperostosis,' as a term, was first coined by Angel in 1966, as a means to describe the 'pathology involving the outer table of cranial vault bones' (Angel 1966; Larsen 2003: 30)[6]. The first major breakthrough into the causes of porotic hyperostosis and cribra orbitalia in Mesoamerican populations was detailed in Hooton's (1940) report from his findings of the skeletal remains recovered from the cenote at Chichen Itza, Mexico and Pecos Pueblo in New Mexico previously discussed (Hooton 1930, 1940, cited in Steinbock 1976: 216-217). Through his work in the Mediterranean, Angel (1966) was among the first to link porotic hyperostosis to anaemia and was also one of the first to implement large scale systematic surveys of human skeletal remains (Angel 1966; Larsen 2003: 33). Angel (1966) suggested that porotic hyperostosis was caused by hereditary anemias, such as sickle cell anaemia. Iron deficiency anaemia however, became the frontrunner as the cause for porotic hyperostosis once cases were discovered in regions and timeframes where genetic anaemias had never occurred prior to European expansion (Larson 2003: 40). Occurrence of this pathology cannot be explained by genetic factors in these areas. In Mesoamerica porotic hyperostosis and cribra are the two symptoms most commonly associated with iron deficiency anaemia and parasitism, and at times they are also associated with scurvy (Wapler *et al*., 2004: 333).

Throughout Mesoamerica there is great variability in the occurrence and severity of porotic hyperostosis and cribra orbitalia: and these inconsistencies might be caused by regional differences in parasitism as well as in diet (Wright and White 1996). Wright and White (1996: 160) highlight the possibility that differential decay rate of immature crania compared to adult crania might play a role as to why porotic hyperostosis levels are not as high at some sites compared

[6] Some of the first studies of porotic hyperostosis and cribra orbitalia, just after the turn of the twentieth century, state that they were perhaps caused by carrying heavy loads on the head, such as water jugs (Smith and Jones 1908, cited in Wright and Chew 1998) In the 1920s, the leading hypothesis as to a cause for the lesions was thought to be cranial modification preformed in infancy and early childhood by binding a board to the cranium to elongate the skull or otherwise modify it (Williams 1929). Neither of these aetiologies is accepted in current studies.

to others. In addition, it appears that sites nearest the coast were less affected by porotic hyperostosis and this would be congruent with the theory that porotic hyperostosis is linked to maize consumption, as maize was a smaller portion of the diet at coastal Maya sites (Wright and White 1996: 160-161). The occurrence of porotic hyperostosis shows a tendency to change through time however. For example, at the site of Lamanai, Belize, porotic hyperostosis was found to be more frequent throughout the Postclassic than it was during the Classic period, and was even higher in the colonial period, and this does indeed parallel an increase in the consumption of maize, something which has been documented using stable isotope methodology (Wright and Crew 1998: 927).

3.5.5 Nonspecific Infection: Osteomyelitis and Periosteal Reaction

Nonspecific infections on bone are often found in osteological samples. In ancient Maya skeletal populations, the most frequently observed types of bone lesions are osteomyelitis and periosteal reaction. The former affects the marrow and endosteal surface while the latter affects the periosteal bone surface. When acute, osteomyelitis occurs most often on the proximal and distal ends of the tibia and femur (Aufderheide and Rodriguez-Martin 1998: 174; Rogers and Waldron 1989: 612; Steinbock 1976: 60). Osteomyelitis is caused by an infection of the bone, most often due to pathogens in the bloodstream caused by lesions on the skin or subcutaneous abscesses (Steinbock 1976: 60). If a bone becomes exposed to the external environment, e.g., a compound fracture breaking through the skin, infection can occur. In its most common form, osteomyelitis is caused by the bacterium *Staphylococcus aureus* (Rogers and Waldron 1989: 611; Steinbock 1976: 61). If infection is severe and persistent, osteomyelitis can result in destruction in the surface of the bone, a cloaca that provides a channel through which pus can drain; and over time the affected bone tissue becomes necrotic and dies (Ortner 2008; Rogers and Waldron 1989; Steinbock 1976: 60). In modern cases of osteomyelitis the condition is most often seen in children between the ages of three and fifteen years old (Rogers and Waldron 1989: 612). Since the bacteria causing osteomyelitis are not fast acting and rarely fatal, in ancient remains the disease is commonly seen in fully mature skeletons, although it likely originated in childhood (Waldron and Rogers 1989: 612).

Periostitis is usually of unknown cause but reflects an inflammation or irritation of the periosteum resulting in new, woven bone being laid down on the periosteal surface (Waldron 2009: 115-117). Leading causes of periostitis can include trauma to the skeleton, osteomyelitis, tumours (such as an osteosarcoma), leukaemia, rickets, and syphilis (Waldron 2009: 116). However, in the majority of cases the traits of periostitis are indistinguishable among various different infectious diseases, so differential diagnosis is quite often not possible when dealing with archaeological samples (Ortner 2008).

3.5.6 Skeletal Trauma

There are many causes of fractures: violence, accidents, osteoporosis, and deficiencies in nutrients. In the Maya area, a wide range of skeletal trauma has been recorded. In a review by Serafin and colleagues (2014: 140), 'studies of skeletal trauma in the Maya area have identified: flaying and decapitation, dismemberment, defleshing, parry fractures, and depressed cranial fractures.' Many examples in the list above would have occurred post-mortem and were very infrequent (example: flaying) (Tiesler 2007). Parry fractures, likely the results of accidents, are usually the most frequently recorded skeletal trauma in the Maya region, followed by cranial fractures (Armstrong 1989; Cohen *et al*. 1997: 89). The majority of the studies completed on Maya skeletal trauma are case studies, while there are only a couple of regional studies, specifically as it pertains to warfare (Armstrong 1989; Cohen *et al*., 1997: 78; Serafin *et al*., 2014: 140; Tiesler 2007: 16).

3.5.7 Nonmetric Variation

Nonmetric variation is observed in all biological populations and is often used as a means for examining biodistance (Tyrrell 2000). This is because nonmetrics are inherited and act as good indicators of ancestry or family ties. These traits can include hyperostotic traits, which involve an excess of bone, for example sutural bones, supernumerary teeth, and sesamoid bones. Nonmetric traits also include hypostotic variation, affecting the development of bone, such as metopic sutures and foramina in the sternum and humeral olecranon fossa. They are not pathological or related to disease, and have no adverse effects on health. There are over four hundred nonmetric traits identified that can be found in the human skeleton (Singh and Pathak 2013: 180). At times, they can be mistaken for a pathological trait or trauma, but in actuality they are benign examples of variation within populations.

Sutural bones are found along cranial sutures, typically along the lateral and posterior cranial vault and are the result of the detachment of ossification centres from the cranial bones (White 1996: 396). Sutural bones can be of different sizes and may vary in terms of number present in a single individual, ranging from one to over one-hundred. Sesamoid bones are located within tendons typically close attachment points, and most often in muscles that experience excessive biomechanical stress. They also vary in size and shape, although they are usually not larger than just a few millimetres in diameter (Williams *et al.*, 1989: 457). Sesamoid bones first appear *in utero*, however they ossify in adolescence (Williams *et al.*, 1989: 457). Even though sesamoid bones are sometimes found in the wrists and hands, they are most common to lower limbs, in particular the ankles and feet.

Some examples of nonmetric traits include foramina of the sternum and humerus. The sternal foramen is located on the body of the sternum, and is the product of incomplete fusion at the midline. Only in rare cases is more than one sternal foramen present in an individual (Singh and Pathak 2013: 180). On the humerus, foramina of the olecranon fossa can occur, which can lead to the ability of hyperextension at the elbow.

3.6 Cranial and Dental Modifications to the Skeleton

Cultures which practice bodily modification can be found across the globe, from prehistory to the present. Body modifications can be a means of exhibiting status, gender roles, religious beliefs, or kinship, among other cultural roles and affiliations. In the Old World, one of the first to record such practice was Hippocrates, around 400BCE (Duncan and Hofling 2011: 199). Aristotle also compiled descriptions of cultural body modifications, including that of head shaping (Duncan and Hofling 2011: 199). Not all bodily modifications result in skeletally visible alterations; nevertheless, a range of body modification practices can be observed in archaeological human remains. In the Maya area, and in Mesoamerica as a whole, cranial and dental modification -- both of which are skeletally identifiable -- were the most prevalent forms of cultural bodily alterations.

3.6.1 Cranial Modification

The custom of cranial modification in Mesoamerica began during the Preclassic period, and osteological evidence in the form of artificially modified skulls dates this practice to as early as 8,800BCE (Tiesler 2014b: 234). The practice of Maya cranial modification may have been copied from the Olmec civilization (Goodrich and Leon 2010: 85; Tiesler 2010).

The Maya practiced two main types of cranial modification, each with a number of subtypes (Tiesler 2010) (Figure 3.3): lambdoid flattening and tabular-oblique (Tiesler 2010). These are both further subdivided into erect or oblique styles (Geller 2011; Tiesler 2010) based on the direction of the extension to the normal cranial form. The most common styles of head shaping in the Maya region are fronto-occipital flatting (also termed tabular erect) and tabular oblique modification (White 1996).

Evidence for this pan-Maya practice is not only seen osteologically, but also archaeologically, as representations of fronto-occipital flattening can be found on ceramics, whistles, figurines and carved on stelae (Tiesler 1996: 4; White 1996: 400). With this practice both the occipital and frontal bones were flattened by compressing the bones anteroposteriorly, which created a high-vaulted cranium, and a bulging effect on the parietals (Figure 3.2) (White 1996). The tabular-oblique style of cranial modification is named for the Olmec culture from which it is likely derived, and can be traced both osteologically and through iconography, and is typically found to be a much earlier style (Tiesler 2010, 2011: 122). Fronto-occipital flattening creates elongated frontal and occipital bones, rendering the cranium into a tabular shape (Tiesler 2010; White 1996). At

Lamanai, most of the instances of cranial modification fall into the fronto-occipital classification, as this style was more common throughout most of the Classic Period, whereas the tabular-oblique style seems to be prominent during the Preclassic (Tiesler 2010; White 1996). The earliest lambdoid flattening, one of the foremost styles of Maya head shaping, dates to the early and middle Preclassic period and has been documented at Cuello, Belize (during the Swasy/Bladen phase) as well as Alter de Sacrificios, Guatemala (Xe phase) (Tiesler 2010: 291). Based on head shape it is inferred that many of the same techniques and patterns, which are seen in the Preclassic period, were employed throughout the Classic period and into the beginning of the Postclassic period, the practice even increased in the last horizon (Tiesler 1999: 3).

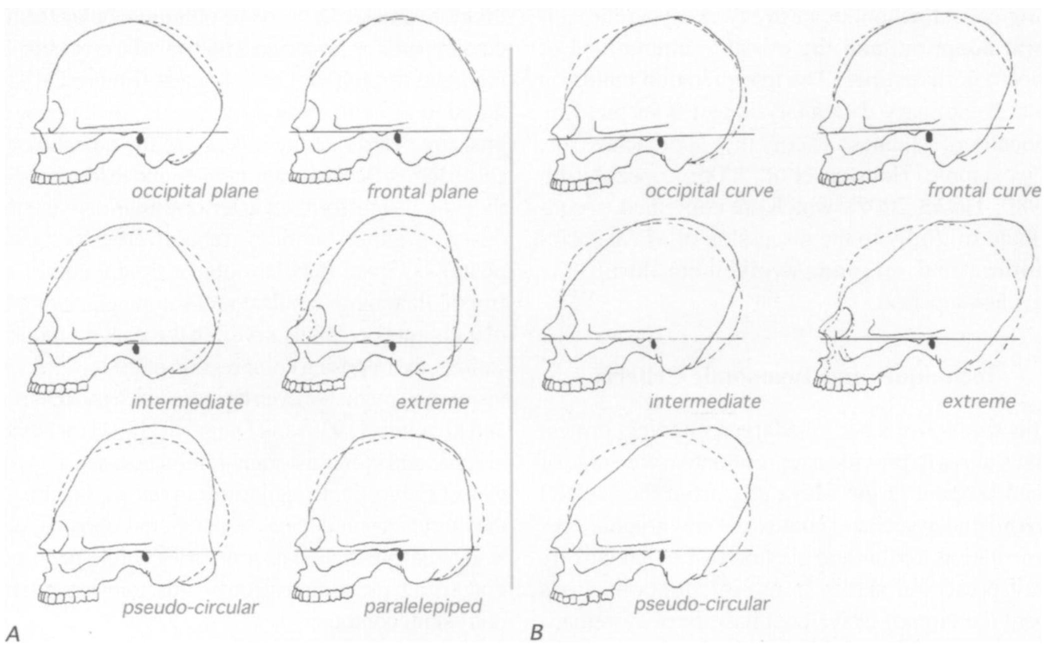

Figure 3.2: Maya cranial modification types, tabular erect (fronto-occipital) (column A) and tabular oblique (column B). From Tiesler 2010: 294.

Bishop Diego de Landa observed the methods employed for cranial modification in the sixteenth century. Landa stated that when the infant was only about five days old, two boards would be placed on the front and back of the infant's head: at the frontal and occipital. These boards were then tightly bound together and left for 'several days' (Duncan and Hofling 2011: 202; Landa 1959:

54). However, it is highly unlikely that permanent deformation could be accomplished within such a short period of time, and rather, as observed in other cultures which practice cranial modification, it likely took up to a year or more before the process was complete (White 1996: 400).

The alteration of the cranial vault was produced through cradleboards and compression headbands (Tiesler 2010: 291). Different methods create differences in the overall outcome of the head-shaping process. The duration and pressure of the cradleboards also affected the shape of the cranial vault, and the application of various combinations of compression boards and headbands would have moulded the cranial vault in particular ways (Tiesler 2010). Tiesler (2010: 293) explained how some of these methods leave less obvious markings on the cranial vault. In contrast, others can create sulci running lengthwise across the cranium by the pressure of headboards or cradles with constricting bands on the external surface of the cranial vault. These sulci might be seen as a by-product of the cranial modification process rather than its initial intention.

The different methods of cranial modification could be read as indicative of different cultural meanings, such as status, kinship groups, ancestry or ideology. Many depictions of Maya deities, in particular of the Maize God, are shown to have modified cranial vaults. In early osteological studies, head shaping among the Maya was considered to be tied to socioeconomic or political status. However, as more excavations and analysis occur, based on the locations of the graves in many different contexts, the current view is that head shaping and status amongst the Maya are not related (Tiesler 1999: 3, 2011: 125). Instead, it is more likely that different cultural affiliations, kinship, and ideological belief systems are the motivations behind Maya cranial modification (Tiesler 2010: 305). Differentiation in the form of modifications among many Maya groups has led to the hypothesis that, rather than being a status marker, cranial modification was an indicator of social amalgamation or relations among kinship groups (Tiesler 1999: 3-4). As Geller (2006: 279) states, Maya skeletal modifications represent ‘a connection between identity constitution and embodied experience.’ Tiesler (2010: 290) suggests that the very nature of practicing head shaping ‘bridges generations,’ as the adults modify the infants’ cranial vaults permanently and the practice is then carried down through subsequent generations and thus the argument for group identity through cranial modification is indeed a strong one. Part of my study will be to test this hypothesis with the northern Three Rivers Region data.

Despite the convincing argument for its practice among kinship groups, ideological factors remain a viable motivation for head shaping. Indeed, when examining artefacts, such as ceramics, stelae, and murals, there are many instances of the depictions of religious ideas and ideals. Amongst these are representations of the Maize God. This god is one of the more prominent deities, and his story is one which reoccurs throughout the text of the *Popul Vuh,* and elsewhere. This story is that of the Maize God, his twin brother, and his sons, the Hero Twins (Christenson 2007; Coe 2005: 66; See Chapter 2.5.)

This is one of the most significant stories in the *Popul Vuh* and the importance of maize as the major food staple cannot be overlooked. What makes this story relevant to the argument that ideology is a strong factor for Maya cranial modification is the body of the Maize God himself. He is forever depicted with an elongated frontal bone and a hairstyle, which together makes him resemble a stalk of maize in a very literal sense (Figure 3.4). As Tiesler (2010: 307) explains:

> The evolving rendition of the Maize God's head shape, rooted deep within the Preclassic past, appears to mirror shifting preferences in artificial head form within the broader Maya area and suggests indeed that this deeply imbedded body practice was already used in the early times to emulate the supernatural and imprint it on both male and female infants.

This argument entails that in practicing cranial modification, individuals among the Maya were both encapsulating their religion into a form which was not only mental but also physical, and that depictions of the Maize God changed to fit the times. The significance of ideology to the practice of cranial modification need not mean that kinship practices did not play a role. It remains possible that both kinship and ideological factors were intertwined, with the practice being enacted in families but also referencing the gods.

Figure 3.3: The Maya Maize God; note the elongated and sloping forehead. Image by J. Kerr, Kerr Number 1185 (Reentz-Budet and Ball 1994: 316).

3.5.2 Dental Modification

Dental modification in the Maya area, like head shaping, has a long history in the region and dates from the Preclassic period (Tiesler 2014b). Modification is found only on the anterior dentition (incisors and canines) of both the mandible and the maxilla, and only on the labial side of the teeth, thus visible. Maya dental modification consisted of two broad categories: dental filing, and tooth inlays, the latter commonly of jadite, hematate, turquoise, or pyrite. Filing is the earliest form of the two, originating sometime during the early Preclassic (Williams and White 2006: 139). Throughout the Late Preclassic and Classic periods many individuals possessed some combination of both inlays and filing. As with cranial vault shaping, styles and inlay material varied both temporally and geographically (Versiani *et al*., 2011: 1003). Based on available data, it has been suggested that the Maya practiced dental modification in higher frequencies than elsewhere in Mesoamerica, particularly in the northern Yucatan (Spence and White 2009: 234).

Dental modification was first noted in the Preclassic, and this custom was widely practiced throughout the Classic and even into the Postclassic. Individuals exhibiting dental modification are found in many different burial contexts (Tiesler 1999: 5; Spence and White 2009; Williams and White 2006). This suggests that rather than dental modification being indicative of high status as was once believed, it occurred across the social strata. It has been suggested that differences in status could, perhaps, be observed through the examination of the different typologies of dental modifiers rather than just the presence or absence thereof. Different types include styles of filings, as well as the type of material used for the inlays (Spence and White 2009: 234). It is possible that, as with head shaping, dental modification might be related to kinship ties through its practice by older family members on younger members (Tiesler 1999: 5).

The means of creating, filing, and inlaying dentition remains largely unknown (Williams and White 2006: 141). However, it is believed that filing was completed through the use of rope drills, powdered quartz in water, and worked bone in order to cut a cavity in the enamel of the anterior side of the incisors and canines (Versiani *et al*., 2011: 1001; Williams and White 2006: 141). In the ethnohistoric literature, Landa (Pagden 1975: 89; Tozzer 1941) described the practice of dental modification at the time of Spanish contact in the Yucatan. In *Relación De Las Cosas De Yucatán,* (Pagden 1975: 89; Tozzer 1941) he stated that the filing was carried out, at least on women, by elderly women using water and ground stones. However there is no mention in the ethno-historic literature at this time of dental inlays being performed, and, in fact, this practice is found to be less prevalent in these later periods (Williams and White 2006: 141).

The custom of dental modification must have been undertaken once an individual reached adolescence, as it was only practiced on the permanent dentition. Skeletal evidence suggests that individuals were typically at least fifteen years old before altering their dentition in these ways (Tiesler 1999: 4-5). At Copán, at the housing complex 9N-8, dental modification was slightly more prevalent in the females (65.5%) than males (58.02%) Whether this pattern is consistent throughout the Maya region, geographically or temporally, has yet to be determined (Tiesler 1999: 4-5).

Many, though not all, of the variations based on these two types of dental modifiers were categorized by Romero Molina in 1970 based on collections at the

Museo Nacional de Anthroplogia in Mexico (Geller 2006: 282; Veriani *et al*., 2011: 1002). Based on his work, the Molina system remains the most comprehensive and widely used system for classifying dental modification types (Brown and Plumer 2013; Geller 2006: 282; Veriani *et al*., 2011: 1002). Molina classified the filing and inlays into seven different types, and within these seven categories there were a number of subtypes, all of which equals fifty-nine different forms of dental modification (Geller 2006: 282; Versiani *et al*., 2011: 1002) (Figure 3.4). Geller (2006: 282) states however, that the Molina categories are 'beginning to show their age; five decades of subsequent excavation and analysis have uncovered several dental modifications that do not fit neatly into these categories.' For this reason, as will be discussed in Chapter 5, detailed descriptors are used in the northern Three Rivers study for the few instances when a particular dental modification does not fit directly into the Molina system of classification. When necessary, these descriptors are also listed in Appendix A

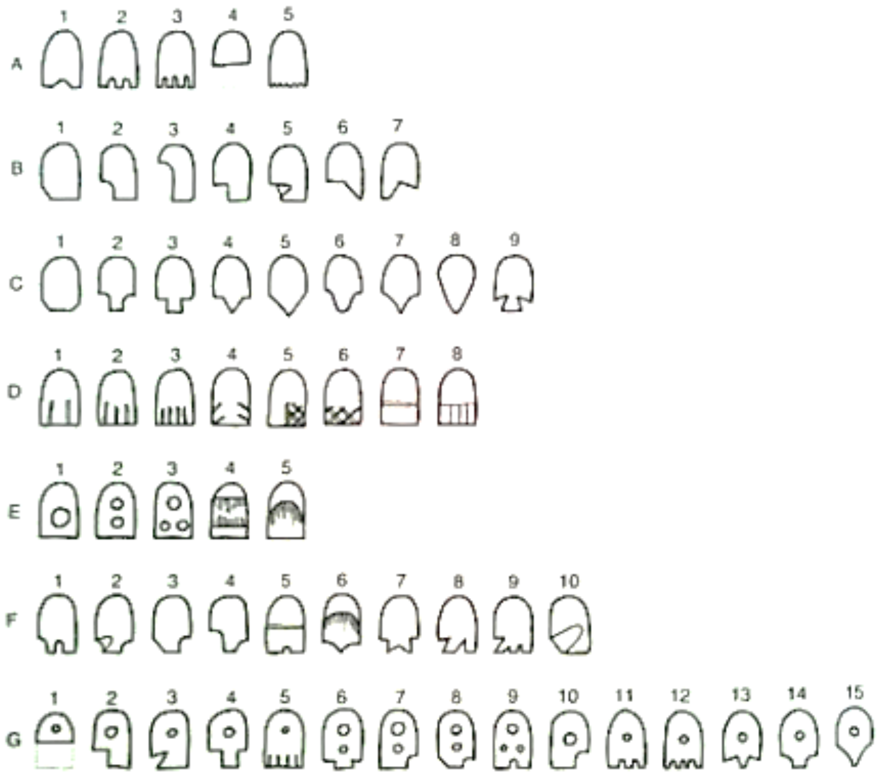

Figure 3.4: The Molina dental modification classification system (Hillson 1996: 252).

There has been some investigation into the correlation between dental modification and dental diseases, such as rates of cavities. It has been recorded that holes created for inlays reached the pulp chamber of many incisors, which 'led to periodontal disease and abscess formation.' (Versiani *et al.*, 2011: 1001). However, copal, the sticky resin of Copaifera trees, was used in the hole for the inlay as it could both kill bacteria and act as a pain reliever (Neiburger 2012: 36-39; Scherer; 2015: 237). Whether or not dental inlays and filing increased the rate of periodontal disease is an issue that will be discussed in greater detail in Chapter 9.

Chapter Four

The Sample and Locational Context

This chapter provides an in depth examination the northern Three Rivers Region. The context for the remains should be fully understood prior to the analysis of those remains, and as such each site is presented with attention to the specific areas or structures in which human remains were buried. First an overview of the northern Three Rivers Region as a whole is presented, then an investigation of each site separately: Blue Creek, Nojol Nah, and Xnoha.

4.1 The Northern Three Rivers Region

The Three Rivers Region is an area of approximately 1600km^2 located in the corner of present-day northwestern Belize (Sullivan 2002: 197). It extends from the Rio Azul in the north (which creates the modern border between Belize and Mexico), to roughly the site of Chan Chich in the south. Irish physician Thomas Gann first explored the site of Blue Creek in the late 1890s while on a caving expedition (McNatt 1996: 81-82). Almost a century later, in 1973, Jaime Awe and Winnel Branche dentified and mapped the site (Driver 2007: 148). Three years later Mary Nievens and the El Pozito Project visited the site of Blue Creek and undertook surveys in the area (Guderjan *et al.*, 1992). In 1992, Thomas Guderjan and colleagues began work through the Maya Research Program, and research has been undertaken yearly since that time, first by Guderjan (1992-2000) then by Lohse (2001-2005) and finally by Guderjan again (2006 to the present). Research focused first in the Blue Creek central precinct (or '*Kawuik*' in Maya [Beach *et al.*, 2014: 3]) and then expanded into the surrounding areas.

A chronological framework for the northern Three Rivers Region is based on extensive ceramic and lithic analysis (Hanratty 2008, 2014; Parmington 2014) as well as architectural data (Barrett 2004; Guderjan 2007). Ceramics dating to the Middle Preclassic have been recorded at numerous sites in the region (Brown 1995; Hammond and Tourellot 1993; Sulivan 2002: 200), including sites within northern Three Rivers Region (Guderjan 2007). Ceramic phases differ throughout Mesoamerica, which gives each region a very specific chronology; the ceramic phases for the greater Blue Creek region are presented in Table 2.2 (based on Guderjan 2007: 12).

Table 4.1: Blue Creek periods and corresponding ceramic phases (Guderjan 2007: 12).

Period	Dates	Blue Creek Ceramic Phase	Regional Ceramic Phase
Early Middle Preclassic	1000-800 BCE	Cool Shade	Swasey/Bladen
Middle Preclassic	650 BCE	Crystal Creek	Mamom
Late Preclassic	350 BCE	Tres Leguas	Chicanel
Terminal Preclassic	100-150 CE	Linda Vista	Floral Park
Early Classic	250 CE	Rio Hondo	Tzakol
Late Classic 1	600 CE	Aguas Turbias	Tepeu 1
Late Classic 2	750 CE	Dos Bocas	Tepeu 2
Terminal Classic	830-1000 CE	Booth's River	Tepeu 3

The landscape in this region is relatively flat; however, the Bravo Escarpment is a major feature in this terrain. The escarpment is named for the Rio Bravo, which, like the ridge, runs on a north-south axis and divides east from west creating the border between the Coastal Belize Zone and the Eastern Petén Zone (Guderjan 2004: 1). The Bravo Escarpment is about 150m in elevation, and can be seen from many kilometres away. The flat land at sea level is situated below the crest of the escarpment and is riddled with hills, caves and *bajos*. The Rio Bravo joins the Rio Hondo, which runs east to the Caribbean and west deep into heart of the Petén. This network of river systems and connection to the Caribbean made coastal trade a substantial aspect of the economic system of Blue Creek. Sites located on the escarpment, such as Blue Creek, the largest of the three sites for the northern Three Rivers Region study, have a wide-reaching view of the landscape. As will be discussed, the location of Blue Creek near the Rio Hondo, as well as areas of fertile agricultural lands, suggests that the area's resources and networks had the potential to generate considerable wealth (Guderjan 2007: 17-18).

The skeletal sample utilized in the northern Three Rivers Region study consists of populations from three study sites: Blue Creek, Nojol Nah, and Xnoha. The populations of Blue Creek and Nojol Nah are of comparable size with 96 and 92 individuals respectively, whereas Xnoha is smaller with a total of 33 individuals (Table 4.1). The skeletal remains are currently housed on site at the Maya Research Program base camp. All 222 individuals from Blue Creek, Nojol Nah and Xnoha were analyzed for my research.

Due to the long excavation history at Blue Creek, the burial number system has been altered or augmented over time. In every instance, however, each site was abbreviated as two letters (Blue Creek = BC; Nojol Nah = NN; Xnoha = XO). When a subarea of the site was involved, it was abbreviated into two letters, for example, Kin Tan at Blue Creek became BC-KT (Table 4.2). Typically, the numbering system was straightforward so that the first burial found at a site was labelled as xx-01, the second as xx-02 and so on. When more than one individual was found within a burial, this was demarcated by adding a letter, for example xx-12a and xx-12b. At Xnoha, with the exception of five burials, there were alterations to the system, with the year of the excavation being incorporated into the labelling system. For example, the second burial found at Xnoha in the field season of 2015 would be labelled as XO-15-02.

Table 4.2: Site abbreviations for the complete dataset.

Blue Creek: Site Core	BC
Blue Creek: Aak Witz	BC-AW
Blue Creek: Buena Vista	BC-BV
Blue Creek: Chan Cahal	BC-CC
Blue Creek: Kin Tan	BC-KT
Blue Creek: Sayap'Ha	BC-SH
Blue Creek: Akab Muklil	BC-AM
Nojol Nah: Site Core	NN
Nojol Nah: Settlement Zone	NN-NOS
Nojol Nah: Tulix Mul	NN-TM
Xnoha: Site Core	XO

When multiple individuals were interred within one grave, each skeleton was treated individually. When analysing grave goods present with skeletons in a multiple burial, each artefact was scored for each individual, as following Wright's (2006) work on the health of the Pasión Maya. As Wright (2006: 43) reasoned, her method is preferable to arbitrarily assigning a grave good to a specific set of remains within the burial. Wright's approach will be discussed further in Chapter 11. As mentioned in Chapter 2, the Maya built structures in many phases, adding burials throughout time. For the northern Three Rivers Region study, unless otherwise stated, the dates given for the burials pertain to the period the burial itself dates to, not necessarily the structure within which it was excavated, although the process of dating a burial can also date a phase of construction.

As the northern Three Rivers Region study examines the interrelatedness of Maya health with location, biological sex, age, and socioeconomic status, a description of the areas where the burials were excavated within each of the three sites, is presented here. This is in order to illustrate the different locations within the three sites where the human remains were excavated, and that sometimes, as will be discussed in Chapter 10, socioeconomic status in the ancient Maya world is not straightforward.

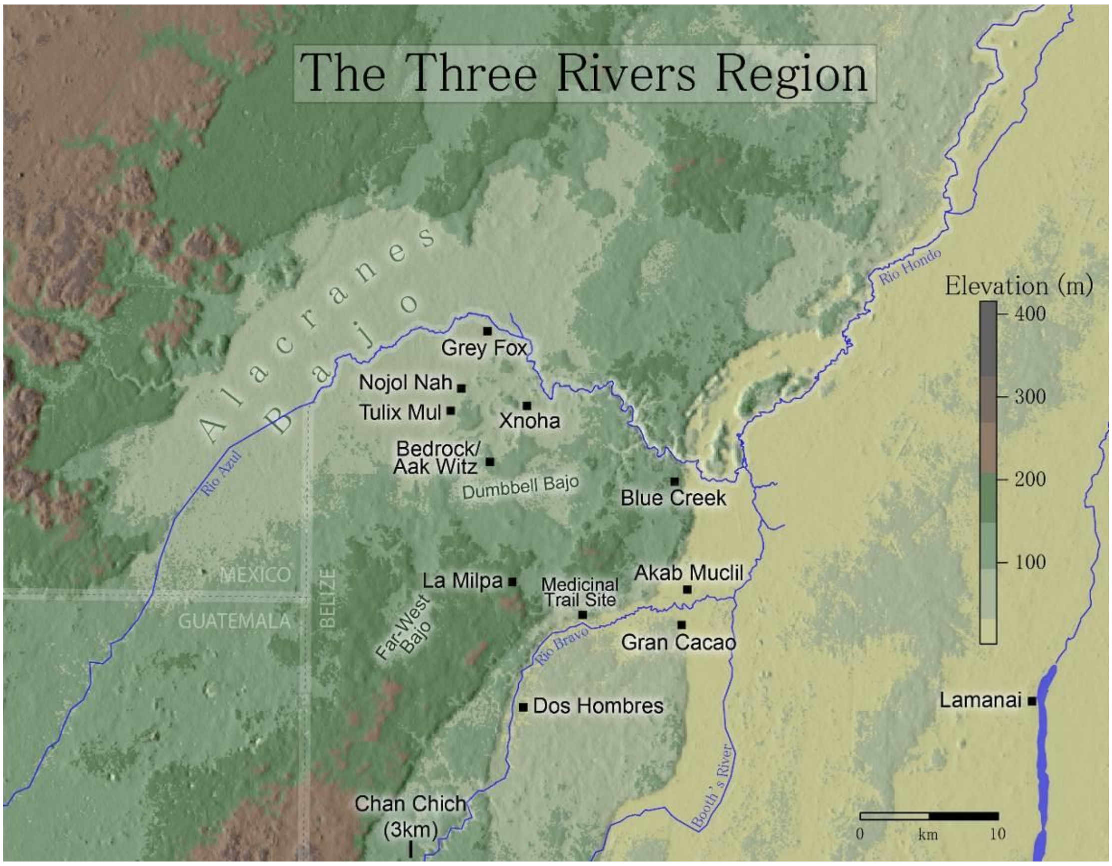

Figure 4.1: Map of the greater Blue Creek region. Map courtesy of G. Hammond 2016.

4.2 Study Site 1: Blue Creek

Detailed here are descriptions of the various buildings and areas, both residential and monumental, where the burials of the Blue Creek sample were excavated. At Blue Creek there are many more areas in which human remains have been exhumed than at either Nojol Nah or Xnoha. While at Nojol Nah and particularly at Xnoha, burials will be discussed at the building level, at Blue Creek there are too many areas to discuss individually and so presented here are primarily the *barrios*, or neighbourhoods, where the remains were found, with a few structures acting as exceptions. One structure at Blue Creek, which contained Tomb 5, is not discussed here. It will be examined in detail in Chapter 10 as it warrants an in-depth approach.

In terms of general population estimates for Maya cities, it is proposed that Blue Creek (Figures 4.1, 4.2, and 4.3) had a relatively low population for a city of its size, roughly 100km^2 are thought to have been under Blue Creek's rule (Figure 4.2) (Guderjan 2007:18-19). Population estimates for Blue Creek range between 15,000 to 20,000 individuals (Guderjan 2007: 7). Guderjan (2007: 18) describes Blue Creek as a 'dispersed mosaic' of land owing to the relative abundance of agricultural fields in the Blue Creek area. The surrounding bajos and fields created a wealth of farmland. In this way, Blue Creek was broken into agricultural lands consisting of ditched fields and terraces as well as public and private spaces with a relatively low house mound count (Figure 4.2), a city centre with land surrounding it, some of it agricultural, some with structure groups. Thus, it is very likely that the 100km^2 area which comprises the Blue Creek city-state did not have the same population density of many sites of comparable acreage (Guderjan 2007: 18).

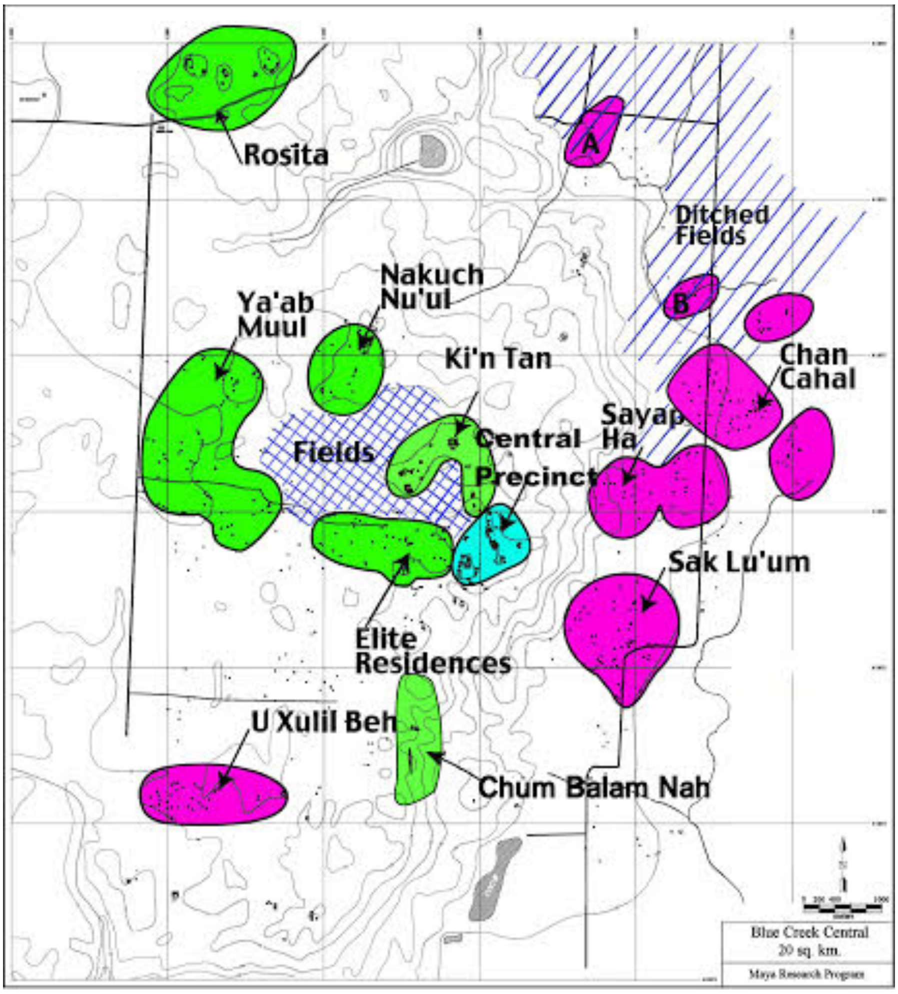

Figure 4.2: Map of Blue Creek indicating a number of the site areas discussed later within this chapter, and their relation to the Blue Creek site core, the 'central precinct' (blue). Elite areas are shown in green, and sub-elite in purple. Agricultural fields are shown in blue hashes and lines. Map courtesy of T. Guderjan 2014.

Since the early excavations at the Blue Creek site core area in 1992, excavations have expanded outwards to include residential groups and other areas. These disparate residential groups support the concept of Blue Creek being both a city but also a ‘mosaic’ of households (Guderjan 2007: 18). As Guderjan (2007: 65-66) explains, ‘each discrete component of the Blue Creek polity exhibits extremely diverse characteristics and is unlike all others…each residential component appears to have housed distinct socioeconomic groups.’ Based on construction methods and materials (large masonry structures versus perishable or crude building materials), as well as location to the site core it is surmised that areas such as Kin Tan (Figure 4.2) housed non-ruling elite, while below the escarpment at Chan Cahal some of the least economically advantaged residents resided (Guderjan 2007: 66). The site of Blue Creek includes material collected from a number of areas which are all part of the Blue Creek site and will be discussed in further detail here and elsewhere within this thesis. These are: Chan Cahal, Chum Balam Nah (CBN), Sayap ‘Ha, Kin Tan, and Buena Vista as well as some outlying burials derived from test pitting and salvage excavations in their environs (Figure 4.2). These are considered *barrios* of the larger site of Blue Creek (Figure 4.2).

Occupation at Blue Creek dates as far back as the Middle Preclassic (650-350BC) up and through the Terminal Classic period (850-1000AD), a period of about 1700 years. Initial occupation began in the Middle Preclassic period, whereas monumental architecture construction began during the Late Preclassic (Driver 2007: 150; Guderjan 2007). It was not until the Early Classic and early Late Classic that the majority of the structures at Blue Creek were constructed (Driver 2007: 150). Through excavation it is surmised that the rate of construction of the monumental architecture began to decline in the middle Late Classic, at which point construction moved towards expanding residential elite structures both within the site core and around the peripheries of Blue Creek (Driver 2007: 150).

The central precinct, or site core, of Blue Creek comprised two central Plazas (Plaza Groups A and B, Figure 4.3), which together consisted of nine plaza groups, with the earliest construction of the site focusing around Plaza Group A as well as in the Chan Cahal residential group (Guderjan *et al*., 2014). Plaza Groups A and B served different functions for the city. While Plaza Group A was a ceremonial centre, complete with a ballcourt and a number of large pyramid structures, Plaza Group B was the residential compound for the ruling elite of Blue Creek and comprised two courtyards (Guderjan 2007; Van den Notelaer 2014: 17). Plaza Group B was continously occupied until at least 500CE, at which time Blue Creek was taken over by another Maya group (Guderjan 2007: 54-55). Even though occupation of the site did continue after this point, it is unclear whether or not the same lineage would have occupied the plaza group's structures (Van der Notelaer 2014: 18). The means of this posited takeover, be that through war or alliance with another polity, cannot yet be determined; however, based on archaeological data to be discussed in Chapter 11, we do know that the government of Blue Creek was indeed overthrown by people from another city-state around this time (Guderjan 2007: 54-55, 73-81).

4.2.1 Blue Creek: The Blue Creek Site Core

The Blue Creek site core consists of two Plaza Groups: Plaza A and B (Figure 4.3). Plaza A comprises an area of about ten-thousand square metres, incorporates six structures located around its periphery and a ballcourt on the northern side. According to Guderjan (2007: 22), this area was 'Blue Creek's major public and sacred space.' The ballcourt is the only one in the Three Rivers Region that dates to the Early Classic, whereas ballcourts at nearby sites such as Dos Hombres and La Milpa date to the Late Classic (Hammond 2015: 97). Plaza B, northeast of Plaza A, runs on a north – south axis and comprises eleven structures (Figure 4.3). Only courtyards and structures from which human remains were recovered are discussed in detail here.

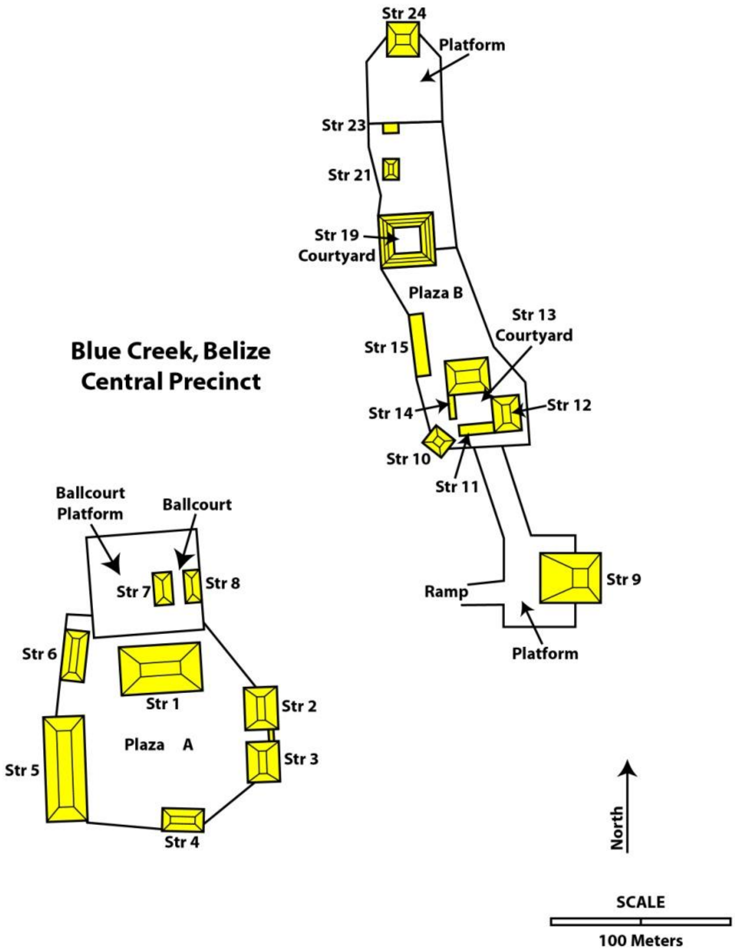

Figure 4.3: The site core of Blue Creek, illustrating some of the structures and groups containing human skeletal remains used in the northern Three Rivers Region study. 'Plaza A' consists of structures 1-8; 'Plaza B' consists of structures 9-24. Map courtesy of T. Guderjan, 2013. Plaza A is located in the lower left corner, while Plaza B is on the right.

Blue Creek: Structure 13 Courtyard Group

The first evidence we have of occupation of the Structure 13 Courtyard Group (see Figure 4.3) is in the Early Classic period, when Structures 10 through 13 were built (Guderjan 1997: 9; 1999: 21). Structure 14 was added in the Late Classic period. Structure 13 is the tallest of the group at 5m in height (Guderjan 1997: 9; 1999: 21). The nature and sizes of the structures of this group suggest that they served religious or administrative functions (Guderjan 1999: 24).

Blue Creek: Structure 19 Courtyard Group

The Structure 19 courtyard group was determined through excavation to have been a large residential elite residence (Lichtenstien 1995: 50). The building comprised fourteen rooms that were constructed during the Early Classic period (ceramic phase *Rio Hondo*) and remained in use through to the Late Classic (ceramic phase *Aguas Turbias*) (Guderjan 1997: 9; 2007: 42). Owing to its central location, its building plan and other evidence from excavation, Guderjan (2007: 43) argues that Structure 19 served as the palace for the ruling elite family of Blue Creek. (Guderjan 2007: 43). Due to the numerous burials within a single bench in Room 1, Guderjan (2007: 43) also argues that a single lineage likely occupied the structure and the courtyard through time.

Blue Creek: Structure 25 group

The Structure 25 group (Figure 4.2 and 4.4) is located just a few metres northwest of Plaza B. The structures formed a residential group of non-elite housing dated to the Preclassic period, with the occupation extending into the Early Classic period (Guderjan 1999: 25; Haines and Wilhelmy 1997). The plaza overlies a Late Preclassic midden, and the group is located near a small reservoir (Guderjan pers. comm. 2016).

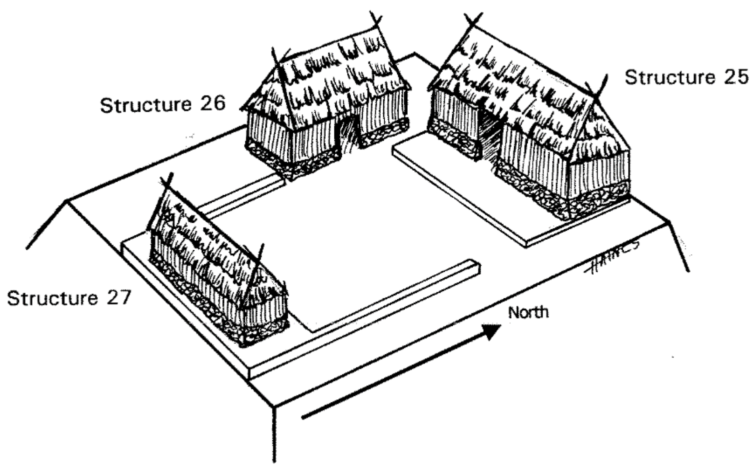

Figure 4.4: The Structure 25 Group, image courtesy of the Maya Research Program.

Blue Creek: Structure 1

Structure 1 is situated within Plaza Group A in the Blue Creek site core (refer to Figure 4.6; Guderjan 2007: 23). It is the largest building in the plaza, rising fourteen metres (Guderjan 1992), within which was discovered the first tomb excavated at Blue Creek (Tomb 1) as well as a number of other burials (Appendix A). Structure 1 dates to the Preclassic, with large construction periods radiocarbon dated to 540 ± 60, the end of the Early Classic. The remodelling of the large columns along the top of the structure was among the modifications completed during this time (Figure 4.5). In total the structure went through six different phases of construction from the Preclassic through Early Classic (Guderjan 2007: 22).

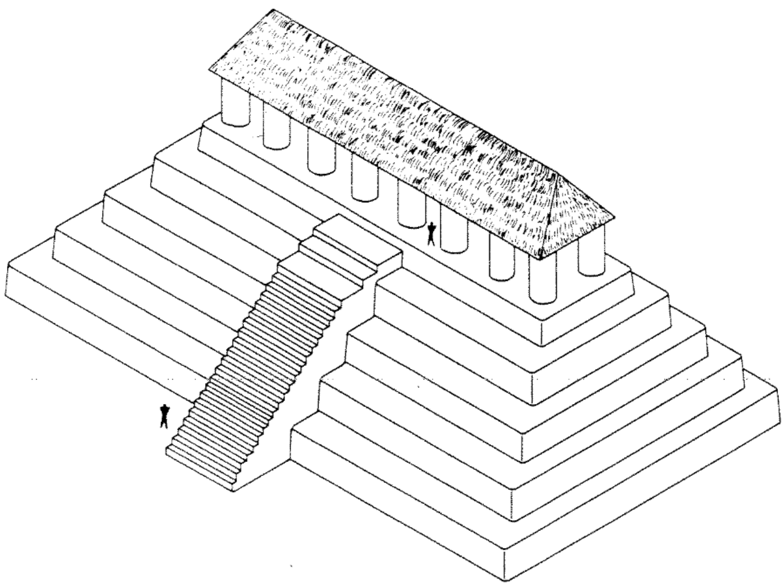

Figure 4.5: Structure 1 at Blue Creek, prior to the remodelling, image courtesy of the Maya Research Program.

Blue Creek: Structure 9

Structure 9 is eleven metres high and situated south of Plaza B Group (Figure 4.6). This structure was built in six separate construction phases (Haines 1995). The original construction phase dates to the Terminal Preclassic (ceramic phase *Linda Vista*) but the structure has been heavily looted throughout its long history and as such not much can be learned from the second and third construction phases (Guderjan 2007: 37). Structure 9, which Guderjan describes as ‘one of Blue Creek’s most important,’ is also known as the Temple of the Masks, due to the five stucco masks which adorn the stairside outsets of the central stair (Guderjan 2007: 37). The ‘ajaw’ glyph appears as a cartouche on the masks, which is highly indicative of them being representative of the ruler(s) of Blue Creek (Guderjan 2007: 37). The masks and the fact that the building is of monumental construction imply to the archaeologists that the rulers of the Blue Creek polity likely utilized this building.

Blue Creek: Structure 24

Structure 24 is the northernmost structure of Plaza B Group (Figure 4.6). Several hundred obsidian flakes were found within this building, evidence of disturbance to the surrounding the area suggested the tomb had been heavily looted (Guderjan 1999: 25). Due to the presence of these flakes, the structure is often referred to as the Temple of the Obsidian warrior in the literature of the site (Guderjan 1999: 25; Haines and Wilhelmy 1997). Great quantities of obsidian were found in burial contexts, and will be examined further in Chapter 10.

4.2.2 Blue Creek: Kin Tan

Kin Tan is situated just to the northwest of Plaza B Group of Blue Creek, and comprises eleven non-ruling elite residences, seven patio groups, three courtyards and one civic-ceremonial group (Guderjan 2007: 73). Kin Tan dates to the Late Preclassic and Early Classic periods (*Linda Vista* and *Rio Hondo* ceramic phases) although many structures of the group also underwent major construction additions during the Late Classic (*Aguas Turbias* ceramic phase) (Guderjan 2007: 54; Hanratty 2007). Even though architectural evidence points to Kin Tan being occupied during the Early Classic period, in the Late Classic this residential group experienced a phase of major construction expansion (Hanratty 2007). Occupation at Kin Tan ceased during the Terminal Classic (Hanratty 2008: 38). This can be seen archaeologically though two large termination deposits found at the Structure 37 Plazuela as well as at Structure 46 (Hanratty 2008: 35-38). Lichtenstein and Hanratty (2002), and Hanratty (2008), excavated Kin Tan.

Since this is a large centrally located residential group, which produced numerous significant artefacts such as carved jade heads and large polychrome vessels, Kin Tan presumably was the residential area for the ruling elite of Blue Creek. The high status of Kin Tan is further supported by the presence of a number of burial assemblages, one interpreted as a shaman and the lineage head (BC-KT-44). Guderjan (2007: 54) suggested that, 'The growing wealth and authority seen in the . . . burial. . . of the Early Classic shaman, is a reflection of this individual and, therefore, his lineage's growing relationship to the nobility living in the core area. It appears that these people's wealth and authority were based on their role in the centralized authority and with the nobility of Blue Creek.' Kin Tan comprises Blue Creek Structures 37, 38, 41, 45, 46, 58, and 61.

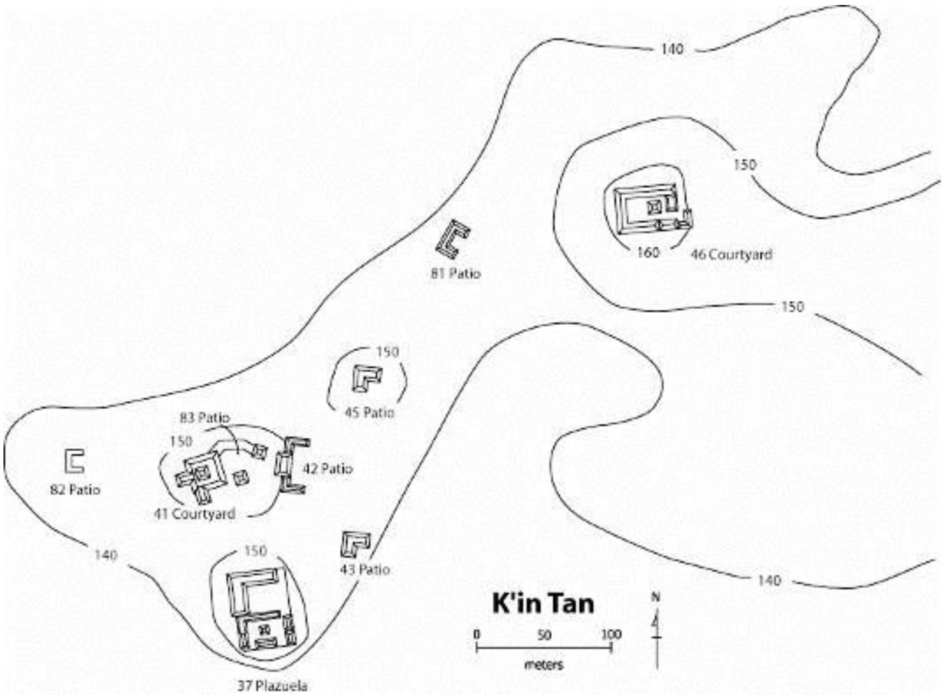

Figure 4.6: Plan view map of Kin Tan, courtesy of the Maya Research Program.

4.2.3 Blue Creek: Chan Cahal

Located just one kilometre east of the Blue Creek site core, and below the Bravo Escarpment, Chan Cahal (meaning 'Place of Little Houses,') is a residential group, or *barrio*, on the eastern side of Blue Creek, beneath the Bravo Escarpment, and was encircled by ditched agricultural fields (Figure 4.2; Guderjan 2007: 66; Popson and Clagett 1997). Chan Cahal comprises a number of house mound clusters which were likely occupied by non-elite farmers living near to the site core of Blue Creek (Guderjan 2007: 66). Excavations at Chan Cahal were conducted by Clagett (1997), Popson and Clagett (1998), Lichtenstien (2000) and Popson (2001). Occupation in this area dates to the Early Middle Preclassic, which means that Chan Cahal seems to have been the earliest inhabited area of Blue Creek[7] (Guderjan 2007: 12; Van der Notelaer 2014: iii). In fact, Chan Cahal has the longest occupation timeframe of any site yet known in north western Belize, spanning from the Early Middle Preclassic through to the Late Classic.

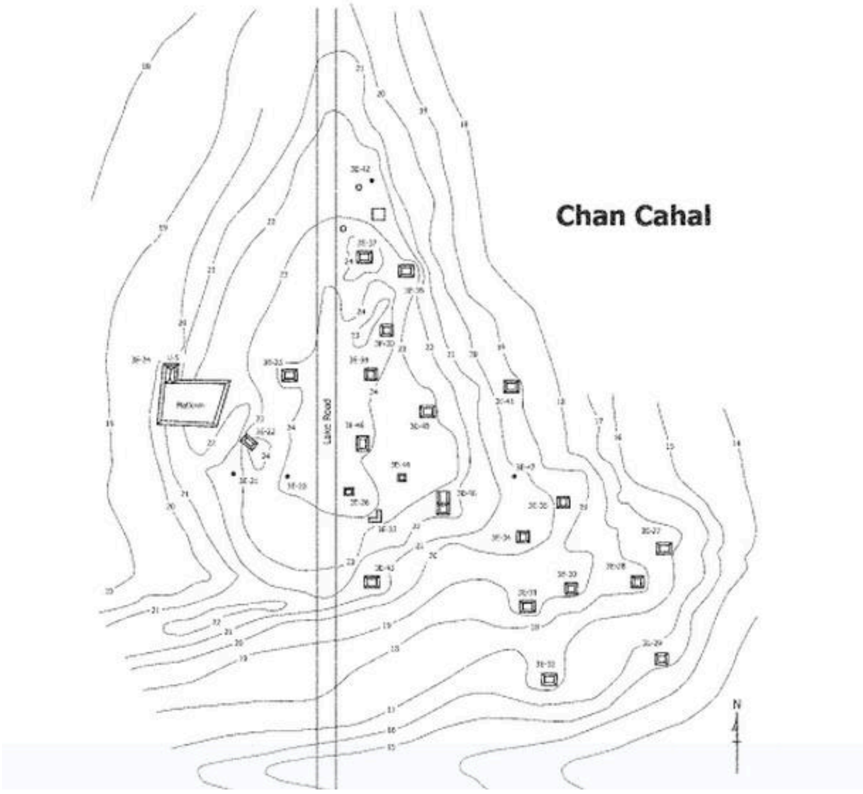

Figure 4.7: Plan view map of Chan Cahal, courtesy of the Maya Research Program.

[7] However, postholes discovered at Kin Tan show that Blue Creek consisted of many perishable structures and dates of the earliest occupation at Blue Creek are thus uncertain (Van der Notelaer 2014: 24).

This community has been studied particularly in terms of agriculture and farming systems; for example, the processing of cacao was carried out at Chan Cahal (Bozarth and Guderjan 1999). However, what is pertinent to the northern Three Rivers Region study are the fifty or so residential structures located within this area. Numerous residential buildings and burials have been excavated at Chan Cahal, of which many date to the Late Preclassic period (Beach *et al*., in press). Chan Cahal has the longest continuous occupational period known thus far in north-western Belize.

4.2.4 Blue Creek: Chum Balam Nah

Chum Balam Nah (CBN), another residential group, is situated near the site core at the top of the escarpment (Figure 4.2). Excavations at CBN began in 2009 and continued through 2013. Chum Balam Nah, which means 'Place Where the Jaguar Sits,' was likely a non-elite residential area, consisting of several courtyard groups and house-mounds, as well as at least two shrine structures. The most well documented area of CBN is a plaza group, which consists of five main structures. The group dates to the end of the Preclassic and continued into the Classic period (Preston and Mastropietro 2010; Preston 2011: 16-20). While the burial goods at CBN indicate the presence of high status individuals, the preservation of the skeletal population at this residential group was very poor. Indeed at times, even though clear burials were excavated, no human remains were found. Poor preservation could be responsible, or perhaps these graves were cenotaphs. Cenotaphs, empty burials or veneration spaces, are common throughout the Maya region (Ashmore 2013: 106-107). However, Ashmore (2013: 106) states 'even the inclusiveness of a cenotaph category is not without a challenge,' this is due to a multitude of reasons, namely the practice of secondary burials, burial caches of femora, crania or phalanges or at times even a single phalanx. It is sometimes difficult to discern if the space was indeed a cenotaph or if the remains simply did not preserve, to the point where even a soil change would not be observable. Chum Balam Nah was excavated first by Preston and Mastropietro (2010) then by Preston (2011; 2012), and Savoie and McLellan (2014).

4.2.5 Blue Creek: Akab Muklil

Akab Muklil, also referred to as the Remple Group, is a residential area located to the southeast of the Blue Creek central precinct (Figure 4.2) (Preston and Guderjan 2011: 20). There are about twelve structures associated with this group, as well as a large shrine reaching a height of about six metres (Preston and Guderjan 2011: 20). Excavations were first carried out here in the early 2000s, and resumed briefly in 2011 (Preston and Guderjan 2011).

4.2.6 Blue Creek: Aak Witz

A residential area located about 15km southwest from the Blue Creek site core (Figure 4.8; Greaves and Guderjan 2012), Aak Witz is part of the mostly unexcavated site of Bedrock (Greaves and Guderjan 2012). Excavations here began in 2008 and lasted through the 2011 field season. While technically not incorporated into the city of Blue Creek, Aak Witz is included here because of its location along the Bravo Escarpment, its proximity to Blue Creek, and because this is the first true osteological study to come out of the northern Three Rivers Region I thought that with fourteen burials it should be included in the study.

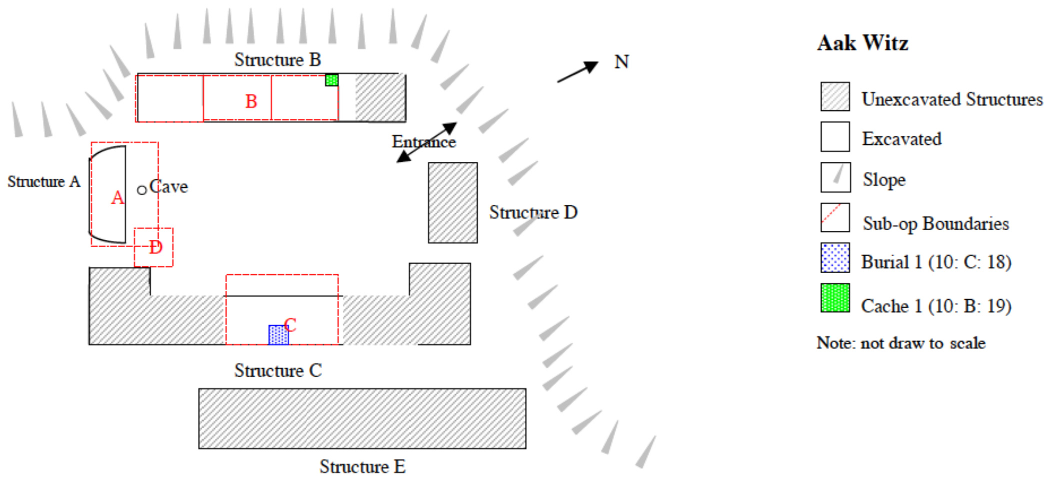

Figure 4.8: Plan view map of Aak Witz, courtesy of the Maya Research Program.

4.2.7 Blue Creek: Sayap Ha'

Located one kilometre east from the Blue Creek site core, Sayap Ha', which translates to 'Spring Water' in Yucatec Maya, is a group of house mound structures covering about 60 hectares of land (Figure 4.2) (Driver 2003: 61). While most of the structures date to the Early Classic, there is evidence of Late Preclassic occupation, and a number of construction sequences that date to the Late Classic (Driver 2003). Five burials come from Sayap Ha'.

4.3 Study Site 2: Nojol Nah

Originally named for 'Northern Group,' or 'Northern House,' the site of Nojol Nah (Figure 4.9) is positioned roughly 9.2 km east and 4.5 km south of the Mexican border in the northwest corner of Belize. Through settlement surveys in 2009 and 2010, a small central precinct was identified as well as numerous structures identified as monumental architecture, including sixteen sub-elite residences and patio-groups, four *chultuns*[8], and a seven-metre high civic temple. In total this city encompasses roughly $4km^2$ of land (Brown *et al.*, 2014: 191). The site is located along the southeast corner of the Alacranes *Bajo*, and is not far from the larger Dumb-bell *Bajo* just to the south (Figure 4.1), both of which would have been rich food production areas during the time of occupation.

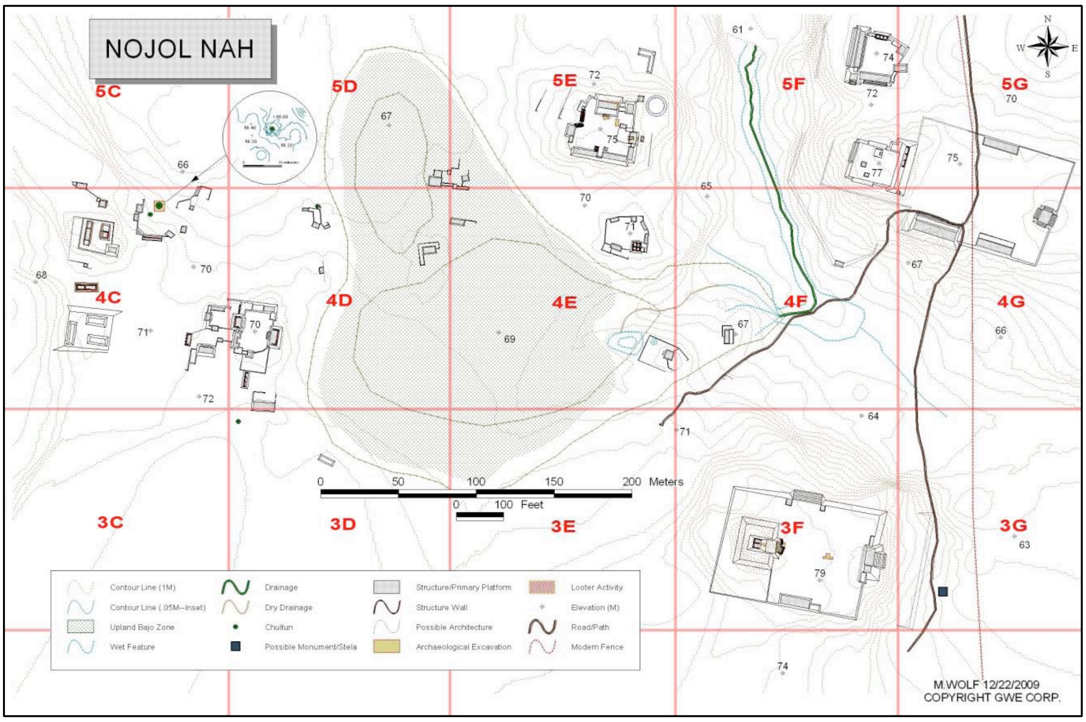

Figure 4.9: Plan view map of Nojol Nah Site Core; map courtesy of M. Wolf.

[8] *Chultuns* are areas of underground storage. They can be either man-made or natural sinkholes in the eroded limestone, or a combination of both.

As an archaeological site Nojol Nah was discovered relatively recently. In 2004 the cutting of a new logging road uncovered a large deposit of chert tools, flakes and bases, and from 2005 until 2013, excavations were carried out annually. However, it was not until the 2008 field season that the focus of excavations at this site shifted from the lithic concentration to household archaeology, and in doing so to funerary archaeology (Barrett and Brown 2008: 34). Nojol Nah was excavated by Barrett and Brown (2009; 2010), Barrett (2011), Brown (2010; 2011; 2013), and Brown and Plumer (2012), while the settlement zone and Tulix Muul were excavated by Hammond (2012; 2013; 2015; Hammond *et al*., 2014). A seven-metre tall pyramid structure is located in the central precinct of the site, and was terminated by the end of the Early Classic. Towards the end of the Early Classic a large *chultun* was buried underneath an elite residential group (Guderjan *et al*., 2015). The ceramics and various other artefacts excavated within this *chultun* are unique to north-western Belize and the styles of which are originally from Naranjo to the west, in Guatemala and perhaps the residents of Nojol Nah migrated from that area (Guderjan *et al*., 2015).

Due the number factors discussed in Chapter 3, skeletal preservation in much of the Maya area is poor; however skeletal remains excavated at Nojol Nah can be very well preserved. Nojol Nah contains several different types of burials, both primary and secondary. There are crypts and cists, and these burials are exceptionally hermetic, largely because the majority of them are found well below plastered limestone floor surfaces, and at times under multiple layers of construction phases.

The residents who occupied much of Nojol Nah are perhaps most aptly termed as ‘rural elites’ (Guderjan *et al*., 2015). This is true also of the residents of Blue Creek and Xnoha. This implies that the people living in the central precincts of these cities were perhaps elite by local standards (Guderjan *et al*., 2015), as will be discussed in Chapter 11. In the way that Blue Creek comprises archaeologically other small areas, such as Chum Balam Nah or Kin Tan, Nojol Nah also has slight variation within its overall general borders. Beginning in 2011 test pitting was undertaken in the Nojol Nah settlement zone (Hammond 2011). Through that initiative, excavations began in 2012 at a small acropolis which overlooks the

Alacranes *Bajo*. Currently it remains unclear whether the site of the acropolis, Tulix Mul, is a separate polity or tied in some manner to Nojol Nah. For the purposes of the research presented in this thesis, Tulix Mul will be included as part of of Nojol Nah (Figure 4.10). Finally, the test-pitting efforts in 2011 also yielded skeletal samples in the settlement zone between Nojol Nah and Tulix Mul, and so a small portion of the overall Nojol Nah skeletal assemblage comprises individuals from these test-pitting efforts.

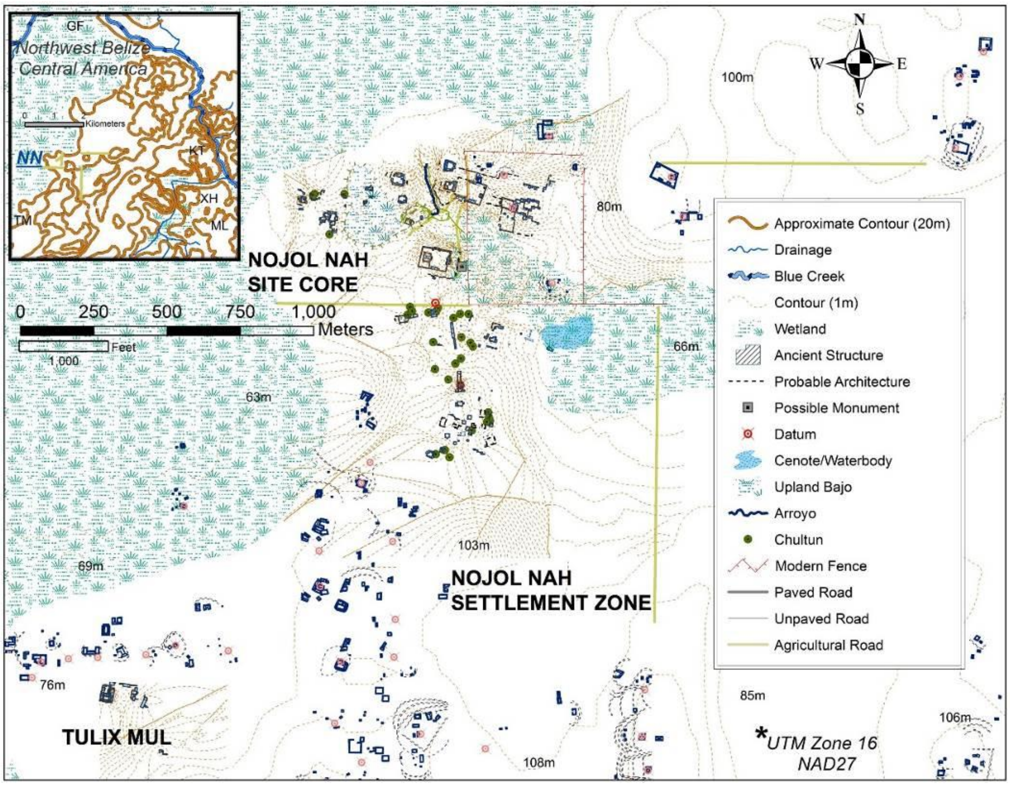

Figure 4.10: Nojol Nah Site Core, Settlement Zone and Tulix Mu; map courtesy of M. Wolf and G. Hammond, 2016.

Extensive data collection since 2008 has revealed that construction at Nojol Nah ceased during the Early Classic period. At this time a large special deposit was buried in a *chultun* under Structure 4C11. This halt to construction during the Early Classic is also the case for the site of Tulix Muul, and it is highly likely that these two events were related (Guderjan 2015: 13). Guderjan (2015: 13) argues that cessation of construction in the Early Classic at Nojol Nah and Tulix Muul could be indicative of the growth and expansion of Xnoha westward during this time. If the case this would mean that beginning at the end of the Early Classic period, Xnoha controlled an area roughly fifty square kilometres and half the size of Blue Creek (Guderjan 2015: 13).

Despite its size, Nojol Nah yielded a skeletal population of comparable size to Blue Creek. The burials excavated at the Nojol Nah site core are some of the most complete and well preserved in the entire assemblage. Forthcoming discussion focuses, therefore, on structures at Nojol Nah which have yielded skeletal remains, Nojol Nah's wider settlement zone, and Tulix Mul. A total of 92 individuals were recovered from excavations within the structures at the site. Each individual structure contained between one and eighteen individuals (Figure 4.11).

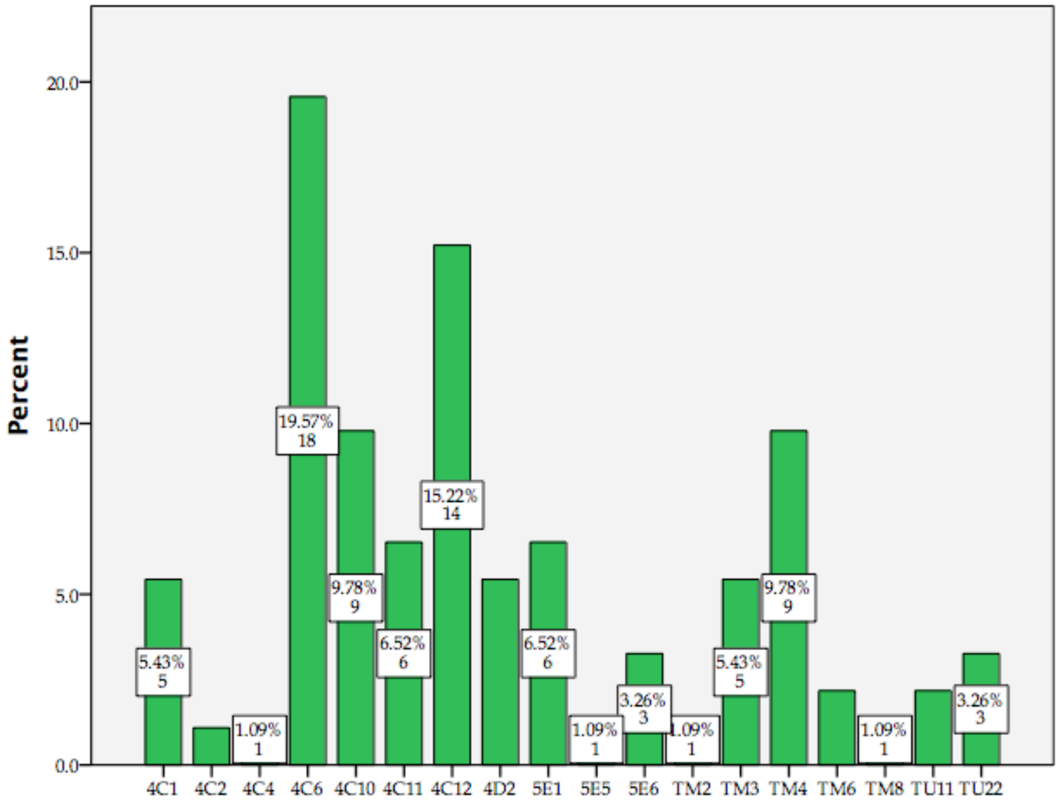

Figure 4.11: Number and proportion of individuals from Nojol Nah recovered from each structure. Those structures beginning with 'TM' are structures at Tulix Mul, of which there were only eight, and only four of them have yielded skeletal remains. Those beginning with 'TU' represent the Nojol Nah settlement zone, and all other structures fall within the site core of Nojol Nah.

4.3.1 Nojol Nah: El Palacio Courtyard, Nojol Nah Site Core

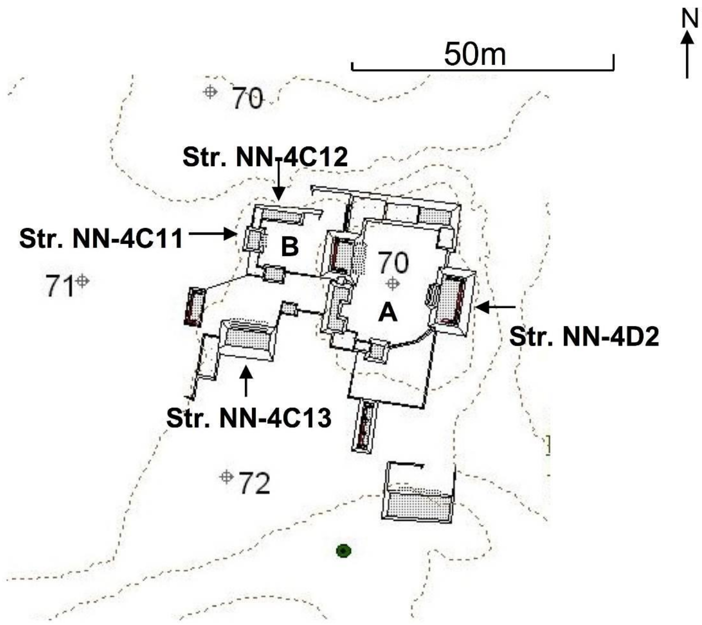

Figure 4.12: El Palacio Courtyard group. Map annotated by G. Hammond (2016) from M. Wolf.

The El Palacio courtyard group was constructed in multiple phases (Figure 4.12). It dates primarily to the Early Classic period, with the exception of Structure 4D2 which predominantly dates to the Late Terminal Classic period. Structure 4D2, the largest of this residential group, yielded four distinct burials (NN44-48) and was constructed in at least two phases (Brown *et al*., 2014: 203).

To the west of 4D2, Structures 4C11 and 4C12 create a corner for the courtyard group and the area where the two adjoin was likely used as a small palapa[9] area (Brown *et al*., 2014: 223). Six burials (NN-50, NN-63 through NN-67) were excavated in structure 4C11, and fourteen -- the second largest skeletal group found at Nojol Nah-- were excavated from within 4C12 (NN-49, NN-51—NN-62). The plan-view map shows the locations of each of the burials found in those two buildings (Figure 4.13).

[9] Palm roofed shelter.

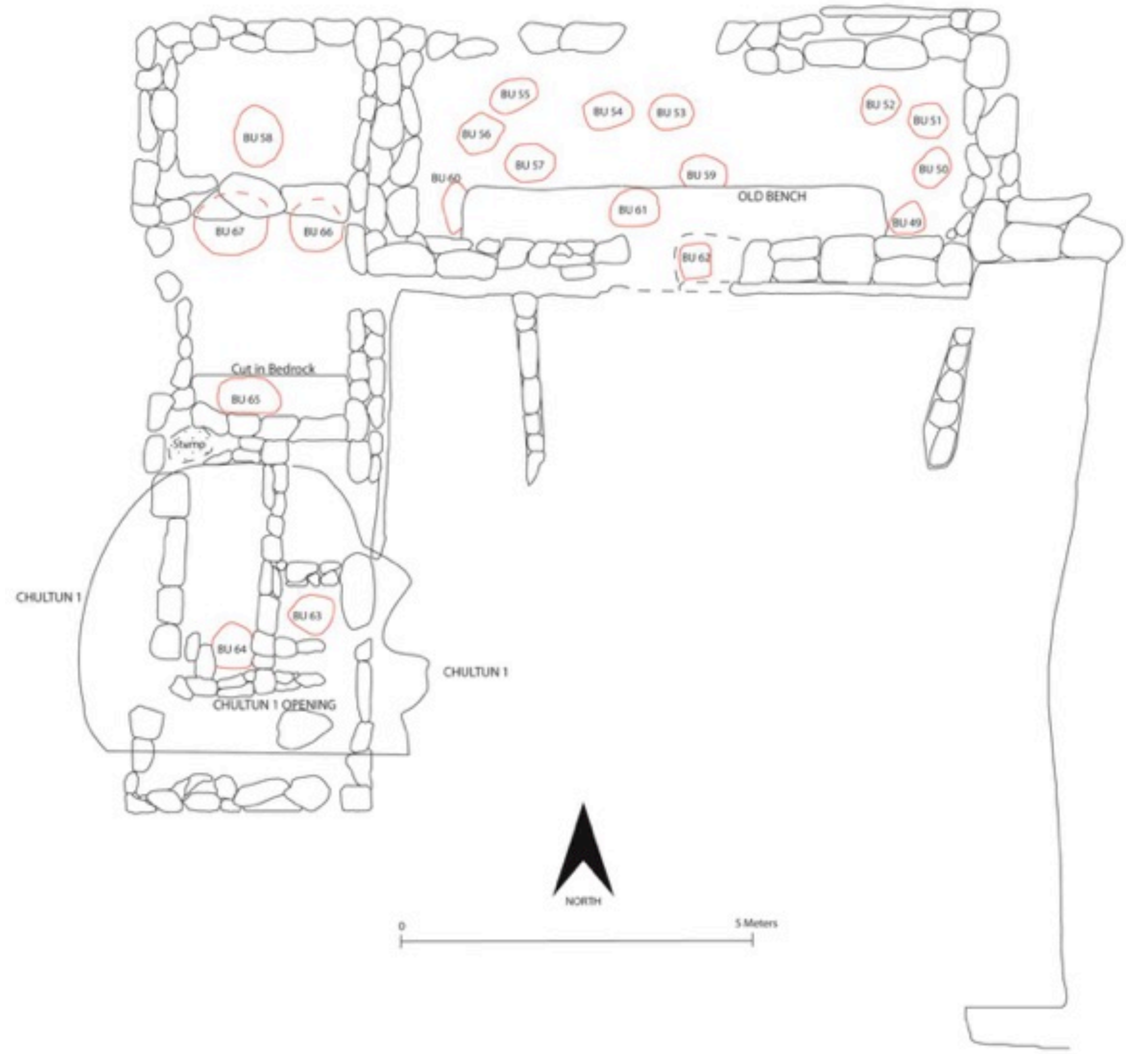

Figure 4.13: Str. 4C11 (left) and 4C12 (top) and burial locations (outlined in red). Map courtesy of B. Deschenes, 2013.

Both structures 4C11 and 4C12 had multiple rooms and subfloor burial benches as well as simple subfloor burials within the construction fill (Figure 4.13). The floor of the southernmost room of 4C11 was also used to seal off a large *chultun* underneath the structure, as can be seen outlined in Figure 4.13. For more information on this *chultun* and the subsequent sealing and demarcating of it, refer to Brown *et al*., 2014.

4.3.2 Nojol Nah: Operation 3, Nojol Nah Site Core

This area of Nojol Nah is just to the west of the El Palacio Courtyard and again comprises a residential area. The operation investigated two structures, Structure 4C6 (Figure 4.14), and 4C1. Structure 4C6 (4.14) yielded the highest number of skeletal remains in the entire skeletal assemblage, and this extends not only to other parts of Nojol Nah but to Blue Creek and Xnoha as well. Structure 4C6 is composed of four rooms. Burials NN-3a, NN-3b, NN-3c, NN-4, NN-7, and NN-10a through NN-19 were all excavated within this structure in various burial contexts ranging from subfloor burials to burials in benches (Brown 2010). This was a residential structure, given relationship of the building's location to the monumental architecture of the site core. The restricted access into the building itself suggests further that it was likely an elite residence (Brown 2010: 101). Structure 4C1 is a residential structure within which five burials were excavated in 2008 (Barrett and Brown 2009: 66).

Figure 4.14: Room 1 of Structure 4C6. Photo courtesy of the Maya Research Program 2010

Structure 4C10 (Figure 4.15), part of a residential courtyard just south of 4C6, yielded nine sets of skeletal remains. Similar to 4D2 in the El Palacio courtyard, seven of them were secondary burials in cyst or crypt-like limestone lined burials (Brown 2010) in Room 1 as can be seen in the plan view map below (Figure 4.15). The two remaining burials were bench burials excavated within Room 3. The structure itself, as with much of the Nojol Nah site core, has been dated to the Early Classic (Brown 2010, Hanratty pers. comm. 2015).

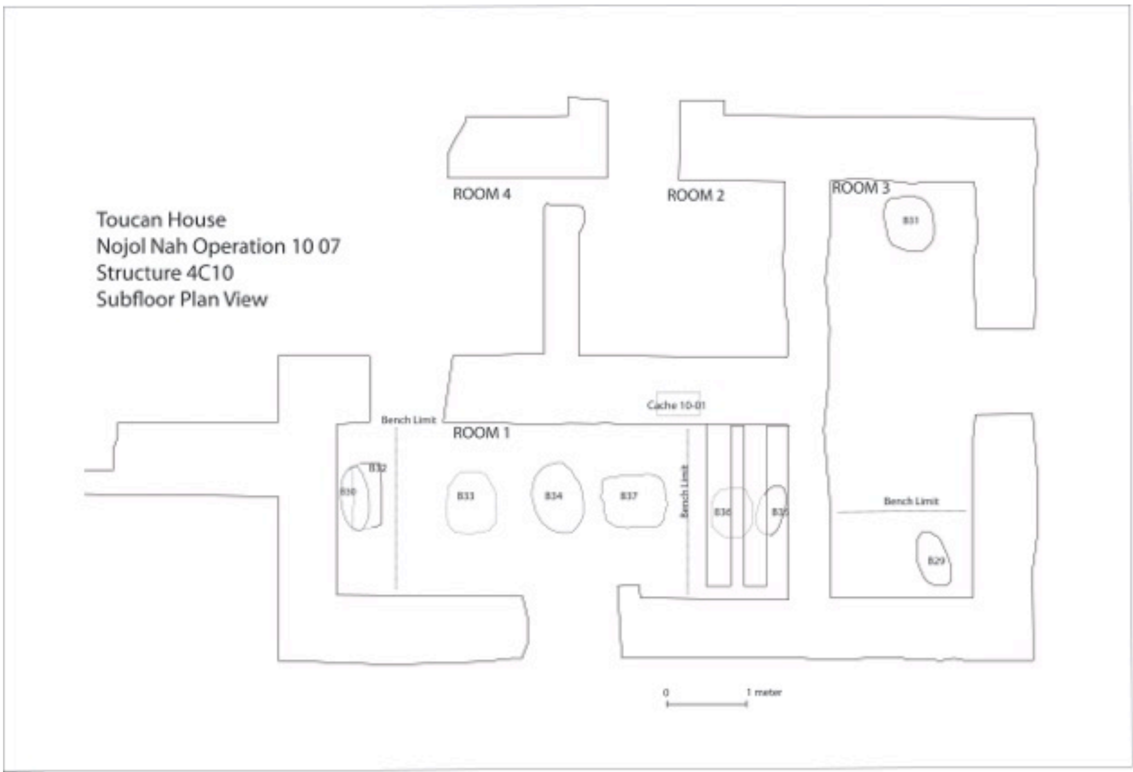

Figure 4.15: Plan view of structure 4C10, subfloor with the location of burials noted. Map courtesy of the Maya Research Program, 2013.

4.3.3 Nojol Nah: Courtyard 5E, Nojol Nah Site Core

Structures in the 5E courtyard group (Figure 4.16) lay just to the northeast of Operation 3 and El Palacio, about 200 metres into the treeline of the present-day forest. According to ceramic analysis, structure 5E1 dates to the Late Classic (Dickson *et al*., 2010). Six burials were found within this structure; each were subfloor burials within the cobble construction fill. Structure 5E5 has been dated primarily to the Late Classic period, however the three burials within it date to the

Early Classic (NN-25, NN-26, and NN-27) (Barrett 2009: 54).

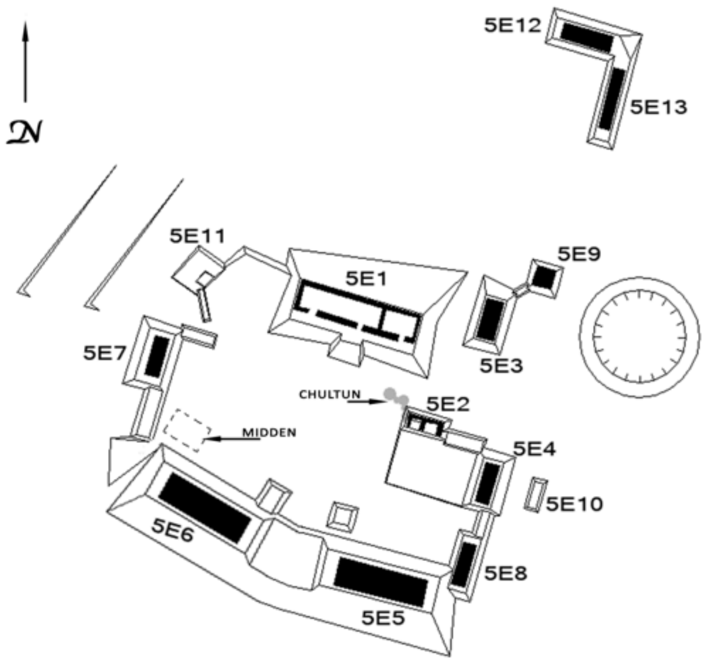

Figure 4.16: Plan view of courtyard group 5E at Nojol Nah, note in particular structures 5E1, 5E5 and 5E6. Map courtesy of the Maya Research Program, 2009.

4.3.4 Nojol Nah: The Nojol Nah Settlement Zone

The Nojol Nah Settlement Zone (Figure 4.17) was the site of a test pitting effort in 2010 and 2011 (Hammond 2011; 2012). The settlement zone comprises an area which surrounds the Nojol Nah site core, from the site core to Tulix Muul. Within this settlement zone two test units (TU11 and TU22) revealed human remains. TU11 was a test pit within a residential structure that had been partially destroyed by the construction of a cattle road just outside of the forest edge. This road sliced straight through the building and two of the three burials within it (NN-NOS-38 and NN-NOS-40). This bulldozed structure has been dated to the Late Classic period, but the dating of the burials is unclear. There were no diagnostic ceramic materials found within or near the burials and the few ceramic pieces that were interspersed had been disturbed, and so a definitive ceramic sequence could not be obtained (Hammond 2012).

Figure 4.17: Ariel view of the Nojol Nah Settlement Zone; photo credit K. Cox, photo courtesy of G. Hammond, 2016.

TU22 was located just a couple of metres west of TU11, and was the largest of the two structures. It was unaffected by the bulldozing of the road. On a north-south alignment, the structure comprised three rooms (Hammond 2012). The test unit exposed the architecture of the building and revealed that the floor of one room had been burned in a controlled environment, such that the adjoining room to the south was completely unmarked (Hammond 2012). No ceramic or lithic material was recovered at this level, but in the area near the doorway, deer bone was excavated comingled with human long bone fragments (NN-NOS-47). A burial bench containing burial NN-NOS-41 was excavated from within TU22. The few ceramics found within this context were not diagnostic and as such the structure could only be broadly dated to the Classic Period.

4.3.5 Nojol Nah: Tulix Mul

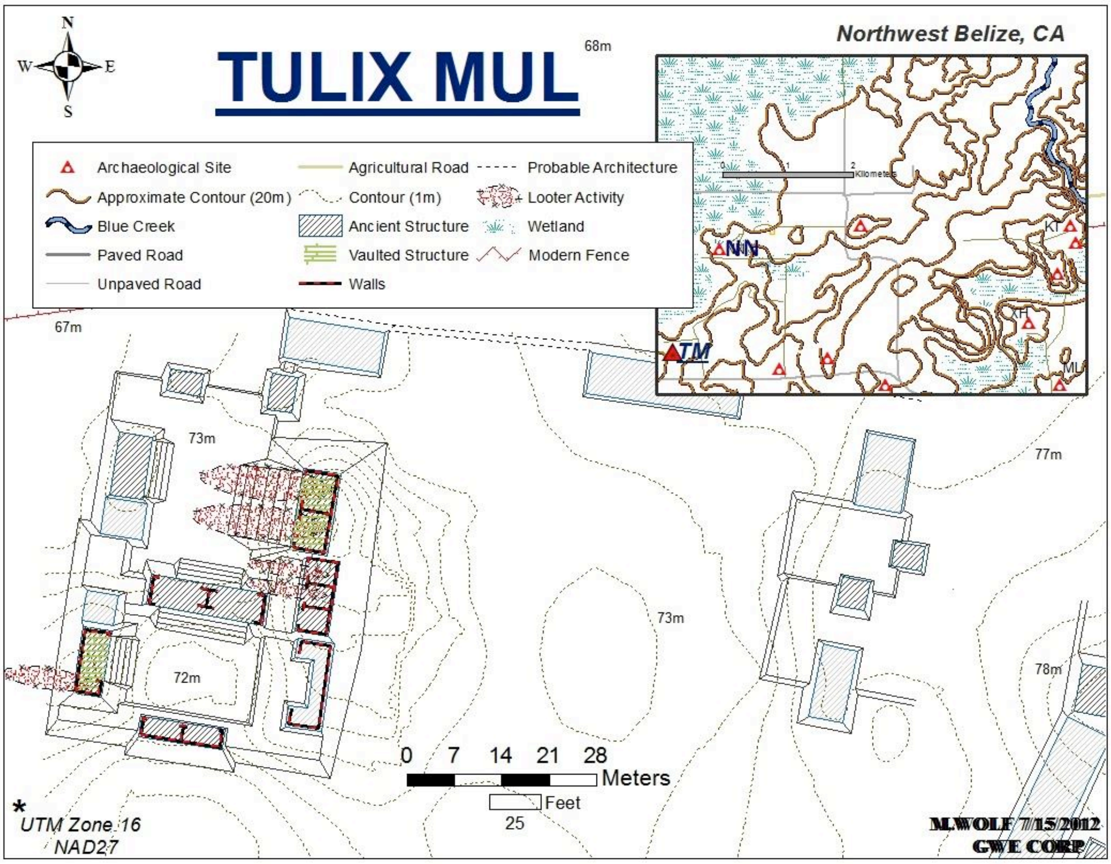

Figure 4.18: Map of Tulix Mul, courtesy of M. Wolf. Inset shows the relation of the Tulix Mul courtyard TM, to the Nojol Nah site core, NN.

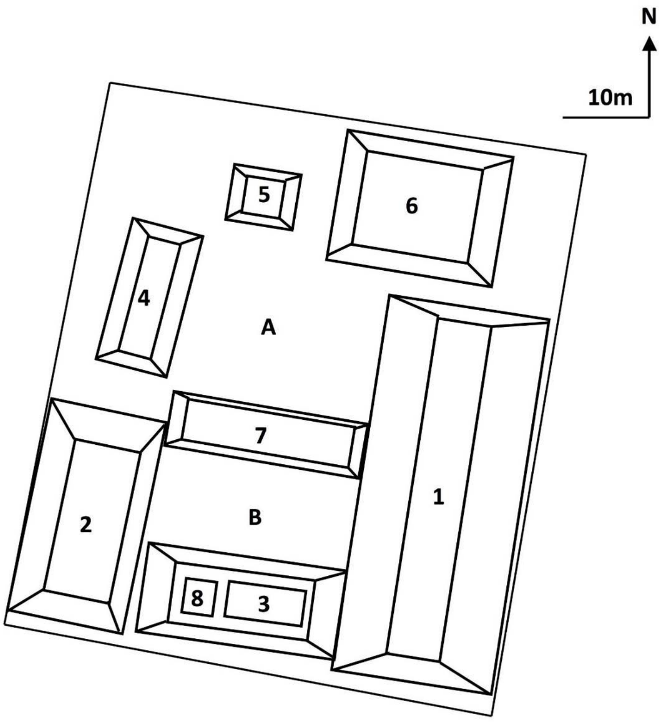

Figure 4.19: Plan view map of Tulix Mul, illustrating structures (1-8) and courtyards (A-B); map courtesy of G. Hammond.

Tulix Mul is a courtyard group across the *bajo* from the Nojol Nah site core and just a few metres from the maximum extent of the Nojol Nah settlement zone. The courtyard consists of eight structures (Figures 4.18 and 4.19); however, only those structures that have been excavated and contained excavated burials will be discussed here. Structure 3 comprised three rooms and is a long structure running east-west along the courtyard. This structure is interesting as it not only contained four burials, but also held three so-called 'micro benches' (Hammond 2015: 148). These are small bench-like areas in the eastern-most room. Structure 4, which has been dated to primarily to the Early Classic, Tzakol 2-3 phase (Hammond 2013: 148) produced seven burials. Structure 6 is a four-roomed building and the most north-eastern structure of the group and dates to the Late Classic period (Hammond 2013: 170).

4.4 Study Site 3: Xnoha

Xnoha (Figure 4.20) is a medium-sized site and at its height was about half the size of Blue Creek. It is located on the highest point between the Dumb-bell Bajo and the Alacranes Bajo (Figure 4.1) and is less than 5km east from the site core of Nojol Nah. Named for the nearby Xnoha Creek, which joins the Rio Hondo from Mexico just north of the site epicentre, the site of Xnoha was first rediscovered in 1991 during a survey of the region (Guderjan pers. comm. 2014; Lohse 2002:08; Parmington 2013: 102). Like many Maya sites, including Blue Creek and Nojol Nah, Xnoha consists of a large number of patio groups, an acropolis, and at least two main plaza areas. Through survey, excavation, and analysis, the patio groups have been interpreted to be elite and sub-elite residences (Guderjan 2015; Parmington 2014; Plumer 2014). It should be noted here that many of the maps and site reports spell Xnoha as IxnoHa or Ixno'ha (Gonzalez 2002; Guderjan 2015; Parmington 2014). The spelling of the site changed so that it would be the same as the spelling of Xnoha creek. Due to this discrepancy there are burial maps and other records within the northern Three Rivers Region study that may have slightly different spellings but the site remains the same.

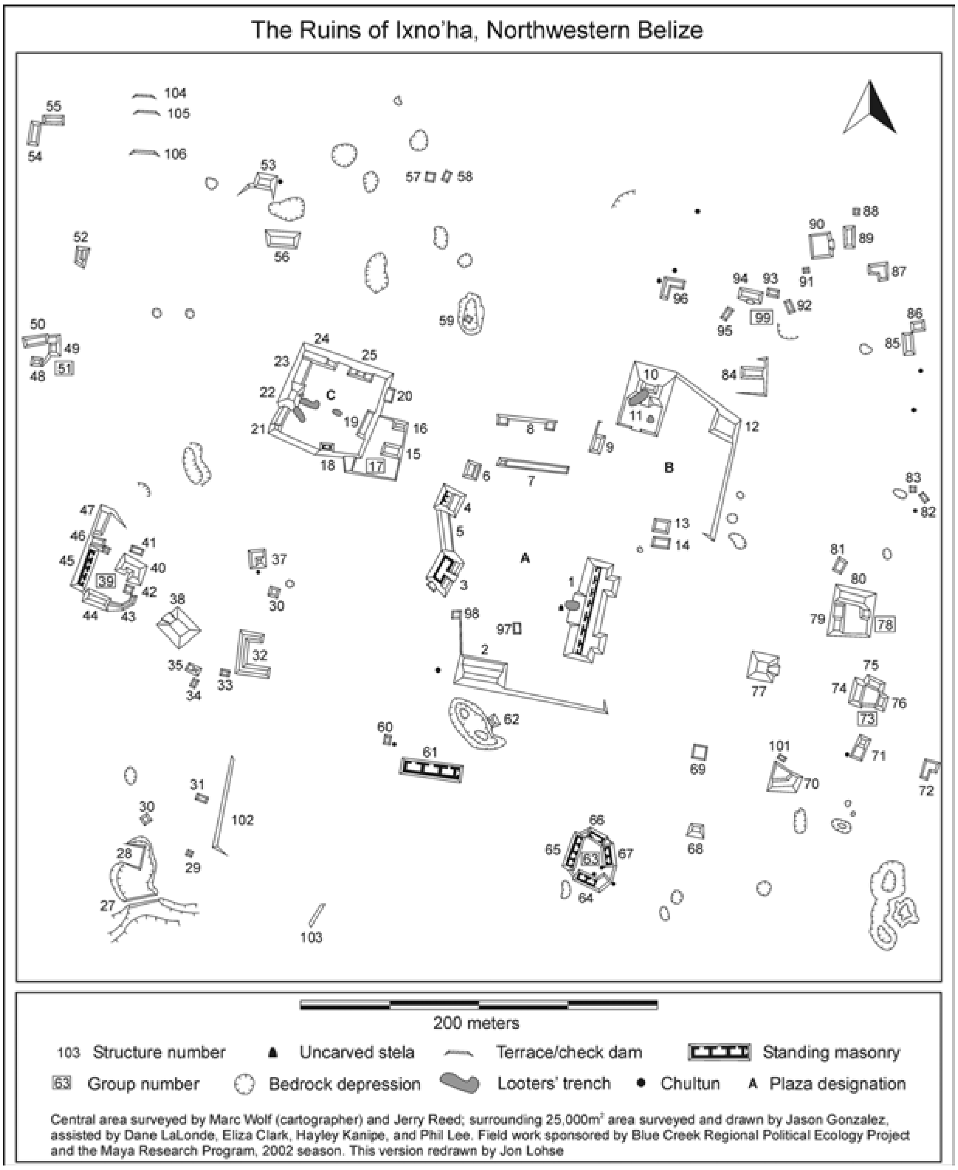

Figure 4.20: Map of the Xnoha Site Core; map courtesy of M.Wolf. Note: a few of the structures discussed in text are not represented within the perimeters of this map.

Xnoha has been excavated thus far by Gonzales (2002; 2004) and more recently by Austin (2016), Preston (2012), Parmington (2013; 2014), Mead (2013), Mead and Mastropietro (2014), Moodie (2016), Pastrana (2014; 2015; 2016), Plumer (2013; 2016a), Plumer and Lincoln (2016), Lincoln (2016), Quiroz and Deschenes (2014); and Quiroz, Savoie, and Deschenes (2016). The first excavations (in 2002) were to determine whether Xnoha was part of the larger site of La Milpa to the south, or if it was-- as further research has proved-- its own separate polity (Parmington 2013: 103). It is currently understood that Xnoha was surrounded by a number of 'satellite' communities, much like Blue Creek and Nojol Nah (Guderjan *et al*., 2015). Since 2012, Xnoha has been the site of ongoing excavations and will continue to be so for the next several field seasons. Research here is focused on sub-elite household groups, as well as some of the larger monumental architecture towards the site core of the site.

Presented here are the structures that have yielded skeletal remains through excavations thus far (Figure 4.21).

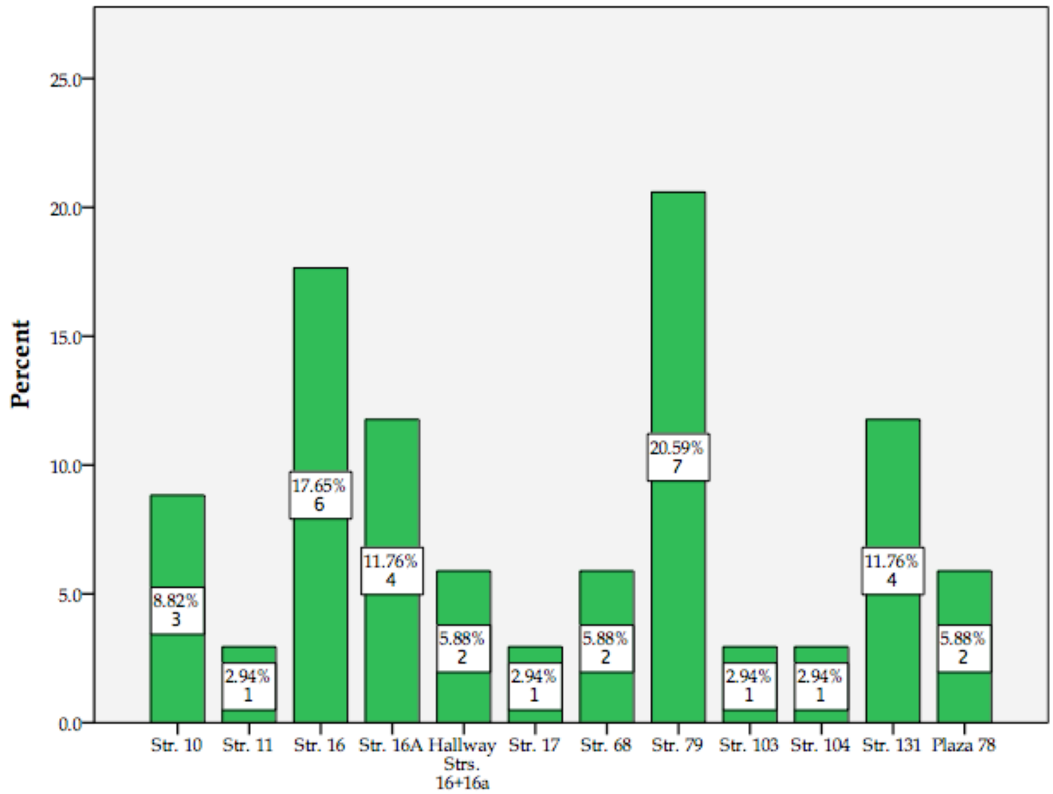

Figure 4.21: Number and proportion of individuals from Xnoha recovered from each structure.

4.4.1 Xnoha: Courtyard Group 65

This is a small courtyard just a few metres south of the Xnoha site core. This courtyard was built in a single construction phase and has been dated to the Late Terminal Classic period (Plumer 2014; Hanratty pers. comm. 2013, 2014). Two of the courtyard buildings have been excavated (Plumer 2014, 2016) and of those two, one building, Structure 68, yielded two burials (XO-13-02 and XO-13-

04). Structure 65 the eastern-most structure in the courtyard, and comprised four rooms built directly on top of the limestone bedrock. Room 3, the smallest room and Room 4 both contained human remains (Plumer 2014).

4.4.2 Xnoha: Patio 78

This patio group is located 200 metres east of the Xnoha site core and is a residential area consisting of three structures (Parmington 2014: 105). Of the buildings comprising this group only one, Structure 79, has been excavated. Structure 79 is a long multi-room structure on the westernmost side of the patio (Lincoln 2016), and yielded seven sets of skeletal remains (XO-14-03, XO-14-05, XO-14-07, XO-14-08, XO-14-09, XO-14-13, XO-14-15). This structure dates to the Late Classic period (Hanratty pers. comm. 2015). The plaza floor itself was excavated in order to obtain a construction date, and in the process two burials (XO-13-01 and XO-14-14) were discovered, along with a large lip-to-lip cache of ceramic vessels (Figure 4.22). Both the burials and the ceramic cache date to the Late Preclassic period (Parmington 2014).

Figure 4.22: Reconstruction of how the Preclassic lip-to-lip cache was found in situ under Patio 78. Photo courtesy of the Maya Research Program, 2014.

4.4.3 Xnoha: Structure 10

Structure 10 is a large monumental structure northeast of the site core. It measures about nine metres in height (Trowbridge pers. comm. 2016). The 2015 excavation recovered human remains from the large staircase of the structure. The human remains were covered in limestone marl on the staircase. The remains do not date to the same period as the structure. According to the ceramic analysis, Structure 10 dates to the Preclassic (Hanratty pers. comm. 2015). However, based on the ceramic sherds found with the marl along with the skeletal remains, the structure served also as the location of activity in the Early Classic.

4.4.4 Xnoha: Structures 16, 16a, and Platform 17

These structures comprise a small plazuela group a few metres west of the monumental architecture of the Xnoha site core. The raised platform of the plazuela group has been dated to the Preclassic period (Mead *et al*., 2014: 51). Through ceramic analysis, the structures of the group, Structures 15, 16 and 16a have all been determined to date to the Early Classic period (Mead *et al*., 2014: 52). The burials found within this area are from within Structure 16, under the platform, and also in the narrow hallway between Structures 16 and 16a.

4.4.5 Xnoha: Structure 103

Structure 103 is part of the Western Elite Residential Group, which is composed of five structures just to the west of Xnoha's central plaza. Structure 103 was a range building, a type which is often present in Maya patio and courtyard groups, and associated with both public and private spaces (Moodie 2016). This structure had two large benches and was split east to west by a small dividing wall (Moodie 2016, Figure 4.23). Within the northern half of the bench was a single burial (XO-15-02).

Figure 14.23: Interior of Str. 103. Photo courtesy of S. J. M. Moodie, 2015.

Chapter Five

Osteological Methods

Throughout the northern Three Rivers Region study, specific methods were used to collect detailed osteological data and to achieve the most accurate and consistent analysis possible. This chapter presents the methods used in the collection of skeletal data, the examination of age at death, sex, health indicators, and cultural skeletal modification. Finally, the statistical software used in the analysis is also presented.

As discussed in Chapter 3, the Maya region has notoriously poor preservation of skeletal remains (Geller 2012: 258; Healy 2007: 262; McAnany *et al*., 1999: 132; Scherer *et al*., 2007: 90; Serafin *et al*., 2014: 142; Tiesler 2007: 16; Wanner 2007: 254; Webster *et al*., 2000: 123). The skeletal sample used in the northern Three Rivers Region study, considered to be well preserved by Maya osteology standards, is very fragmentary. Records were kept throughout analysis on the state of preservation of every skeleton examined. Skeletal preservation was divided into four types (Buikstra and Ubelaker 1994):

excellent, a nearly complete skeleton (>75%) free of limestone plaster and had little to no taphonomic damage;

good, if a skeleton was almost complete (50-75%) and suffered minimal taphonomic damage;

fair, a partial skeleton (25-50%) with taphonomic damage; and

poor, when remains were exceedingly fragmentary (<25%) and or suffered great taphonomic degradation.

State of preservation both in terms of taphonomic damage as well as fragmentation dictated how much of the biological profile could be recorded for each individual within the assemblage. Preservation is a primary matter of concern; given the context of the site, surface preservation of the bone, other taphonomic change, fragmentation, and level of completeness (as defined above) were recorded for each burial. Fragmentation of the skeleton was scored both on the individual skeletal element (example: 80% of the left ulna of NN-64 is complete) and on the burial itself (example: NN-64 is 90% complete). None of the

222 individuals assessed in the northern Three Rivers Region study was found to be complete; however, many were found to be recorded at roughly eighty-five to ninety percent complete. This is particularly true of the Nojol Nah, and to some extent the Xnoha, assemblage.

5.1 Estimating Age at Death

Estimates of adult age at death primarily follow approaches suggested by Bass (1984) and Buikstra and Ubelaker (1994). Both bone development and degradation of bone must be considered when calculating age estimates and in reconstructing paleodemographic profiles. The age categories utilised in the northern Three Rivers Region study are shown in Table 5.1.

Table 5.1: Age categories in the study for all three sites.

Age Category (in years)	Frequency	Percent
Adult	103	46.4
Young Adult [<35]	20	9.0
Middle Adult [35-45]	40	18.0
Old Adult [45+]	28	12.6
Immature	6	2.7
Immature 10-15	11	5.0
Immature 5-10	6	2.7
Immature under 5	8	3.6
Total	222	100.0

Social and biological adulthood are separate distinctions in one’s life course; the former is based on cultural norms and the latter on physiological development (Cucina 2011). In the Maya region social adulthood began as early as the fifteenth year of age (Cucina 2011: 113). Biologically adults were skeletally immature although socially they may have been regarded by society as mature adults. However, because the northern Three Rivers Region study is based on examination of skeletal remains, fifteen years old will still fall into the 'Immature' (adolescent) category rather than the 'Young Adult' category.

5.1.1 Immature Remains

For immature individuals (individuals whose bones had not yet reached full ossification at the time of death) rates of dental eruption were assessed in conjunction with rates of ossification and measurements of overall bone size (Schaefer *et al*., 2009) in order to obtain age estimates. These methods generate the most accurate and precise age ranges (Buikstra and Ubelaker 1994; Meindl and Russell 1998; Schaefer *et al*., 2009; Ubelaker 1989, White and Folkens 2005). With immature skeletal remains, the potential for a narrow age range estimate is higher than for adults, due to the nature of developmental processes in the skeleton, which adhere to set biological timelines and occur in rapid succession during skeletal maturation (Humphrey 1998).

5.1.2 Mature Remains

For mature individuals in the northern Three Rivers Region study, methods I used for aging fully mature adult skeletal remains included dental wear, and the examination of particular joint surfaces: the pubic symphysis, the auricular surface of the ilium, and degeneration of the costochronal joints (Brooks and Suchey 1990; Cardoso 2008; Iscan and Loth 1986; Iscan *et al*., 1984, 1985; Lovejoy 1985; Meindl and Russell 1998). When analyzing mature remains as opposed to immature remains, accuracy can become challenging due to a lack of specificity in the ossification or degeneration of living bone. To tackle this issue, multiple methods were used in my study (Black and Scheuer 1996; Brooks and Suchey 1990; Buckberry and Chamberlain 2002; Buikstra and Ubelaker 1994; Lovejoy *et al*., 1985; Meindl and Russell 1998; Walker 2005). For example, Black and Scheuer's (1996) method for aging the clavicle was advantageous for a number of individual remains. The clavicle is one of the last bones in the body to ossify fully, thus I was able to estimate a precise age range for individuals well into their 20s when one or both clavicles were present. Accuracy and precision in regards to age at death estimates are important factors for both the biological profile of the individual, as well as well for providing information on a population as a whole.

Pelvis

The Suchey-Brooks scoring system was used for the pubic symphysis (Buikstra and Ublelaker 1994: 31-32). This method evaluates the surface of the pubic symphysis thereby allowing for an age range based on the ossification or degeneration of the articular surface, and divides the phases into six categories. However, scoring of the pubic symphysis could only be implemented in a handful of cases due to the general lack of public symphyses within the overall skeletal collection of the northern Three Rivers Region.

The auricular surface of the ilium was analysed following Lovejoy and colleagues' eight-phased method (Buikstra and Ubelaker 1994; Lovejoy *et al*., 1985). The evaluation and scoring of the auricular surface of the ilium is one of the most frequently applied methods of aging the adult skeleton; however, the age categories into which the individual is placed is often broad, with standard errors that range from 7 to 12 years, although this issue is beginning to be corrected (Brooks and Suchey 1990; Buckberry and Chamberlain 2002; Lovejoy *et al*., 1985; Milner and Boldson 2012). Buckberry and Chamberlain (2002) regard the eight-phase method as useful because it can be used in the same manner for both males and females. Furthermore, the auricular surface of the ilium, unlike the pubic symphysis, exhibits significant changes in old age (Meindl and Russell 1998: 385).

Dentition

Occlusal dental wear was assessed and methods were followed that were developed by Smith (1984) and Scott (1979) as suggested in the standards set by Buikstra and Ubelaker (1994). Even though dental attrition is used as a means to ascertain age, it should be noted that this method can be biased by diet regime (Meindl and Russell 1998: 386; Scherer 2004).

Cranial Sutures

Cranial suture closure, both ectocranial and endocranial, as an age estimation tool is a widely used method for gaining a rough estimate of age in adult skeletons (Alesbury *et al*., 2013; Bullock *et al*. 2013; Franklin 2010). However, there is an abundance of cranial modification within the northern Three Rivers Region skeletal sample, and such modifications have been found to alter rates of cranial suture ossification significantly (White 1996). Thus, for the northern Three Rivers study, cranial suture closure methods were not used.

5.2 Estimating Biological Sex

The practice of assessing biological sex can prove difficult if the assemblage is fragmentary, or suffers from severe taphonomic damages. A further issue that is prevalent with sex estimation methods is that many methods are population specific (Walker 2008: 39-40; Walrath *et al*., 2008). This can cause issues if one is analysing skeletal remains from one population but using methods developed on another (Knudson and Stojanowski 2008: 400). Occasionally preservation issues negate the opportunity of determining biological sex. For all of these reasons, I employ the assessment methods listed in Buikstra and Ubelaker (1994) which are the standard for the region and enable comparison to other ancient Maya populations.

5.2.1 Immature Remains

Even though various methods for sexing the human skeleton are commonly used, estimates of sex continue to produce deficient results in a number of critical ways. Perhaps the prominent deficiency is the lack of effective methods to sex immature skeletal remains (Buikstra and Ubelaker 1994: 16; Knudson and Stojanowski 2008: 400; Lewis 2007: 187; Schutkowski 1993). The immature skeleton is not sexually dimorphic, because the individual has not yet reached puberty. There have been attempts to devise methods for determining biological sex in immatures, but these have proven unreliable (Buikstra and Ubelaker 1994: 16; Cardoso 2008; Lewis 2007: 187; Schutkowski 1993; Wright 2006). Due to these issues, biological sex was not assigned to the immature individuals in the northern Three Rivers Region study.

5.2.2 Mature Remains

The most accurate methods for determining sex in adult skeletal remains are through examination of a series of traits located on the pelvic bone and skull (Meindel *et al*., 1985; Spradley and Jantz 2011). For the northern Three Rivers Region study, sex was based on eleven criteria, defined in Table 5.2, which focused on the morphology of the pelvis and cranium (e.g., Buikstra and Ubelaker, 1994):

Table 5.2: Pelvis and Cranial methods for aging skeletal remains

Pelvis Morphology	Sciatic notch angle Medial aspect of the ischiopubic ramus Ventral arch Subpubic concavity Overall morphology
Cranial Morphology	Degree and robustness of the mental eminence Degree and robustness of the mastoid process Severity of the supraorbital ridge (glabella) Severity of the supraorbital margin Severity of the nuchal crest Overall morphology

Each of the traits listed in Table 5.2 was scored on a scale of one through five, with one being indicative of a biologically female skeleton and five being indicative of a biologically male skeleton (Table 5.3) (Buikstra and Ubelaker 1994; Phenice 1969; Walker 2008).

Table 5.3: Biologically female and male scoring system.

Female	1	Biologically Female
	2	Probable Female
	3	Indeterminate
	4	Probable Male
Male	5	Biologically Male

Skeletons were placed into one of five sex groups based on the scores obtained from these methods. Occasionally, preservation issues negated the opportunity of determining biological sex. The individuals who could not be assigned biological sex are termed as sex being 'indeterminate'. When running statistical analyses (see section 4.5) the probable categories were combined to maximise sample size to meet statistical test parameters. See Appendix A for the original sex determinations.

Pelvis Morphology

The sciatic notch is resistant to taphonomic degradation; thus, if the pelvic bones are available, even with a significantly damaged skeletal remains, biological sex can be assessed (Walker 2005: 385). As stated previously, each of the skeletal elements was scored on a scale of one to five based on Walker's scale[10]. Table 5.4 shows the scale for the sciatic notch.

Table 5.4: Scoring method for the sciatic notch.

Female	1	Large and wide
	2	Wide
	3	Indeterminate
	4	Small
Male	5	Small and angular

Cranial Morphology

Analysing cranial indicators has an accuracy rate of 80 to 90 percent (Mays and Cox 2000: 119). However, as Meindl *et al.*, (1985) have demonstrated, as an individual grows older there is a tendency for females to develop more robust skeletal features, whereas males can show a reduction, thereby providing the possibility of male bias in the skeletal sample. As with the pelvis, cranial morphology was scored on a scale of one to five following Walkers' methods (Walker 2005, 2008; White and Folkens 2005: 386-391). As with the sciatic notch

10 Based off of the Phenice (1969) method. Use of this method has an accuracy rate of 96 – 100% (White and Folkens 2005: 398).

scoring, all of these methods use a gradient from one to five in order to reduce subjectivity.

5.3 Health Indicators

While the background, aetiologies and previous research on health indicators were reviewed in the previous chapter, the methods of identification and scoring of health indicators are presented here. These indicators include dental pathology, porotic hyperostosis, cribra orbitalia, degenerative joint diseases (osteoarthritis), skeletal trauma, and presence of lesions. The use of each of the methods detailed in this chapter were supported by previous studies on ancient Maya populations (e.g., Bleuze 2011; Buikstra 1997; Chase 1994; Williams and White 2006; Wright 2004; 2006; Wright and Chew 1998; Wright and White 1996). The presence of pathologies was recorded systematically as identified on a case-by-case basis for all individuals in the northern Three Rivers Region study.

5.3.1 Dental Pathology

Presence of caries, calculus, abscesses, and linear enamel hypoplasia (LEH) was recorded and analysed both at the level of the individual tooth as well as dental arcade.

5.3.1a Dental Caries

Caries were scored as present or absent for each tooth, and when present, the number of caries per tooth was recorded. The size of each caries was placed into one of three categories: small (pinprick sized), intermediate, or large (decay of at least half of the tooth) (Figure 5.1)

Figure 5.1: Example of caries: (left) intermediate, and (right) large; photos by author.

The type of caries present was defined by its location: coronal caries, cervico-enamel line caries, and gross caries. Coronal caries are located on the enamel surface of the crown of the tooth, also termed contact area caries (Hillson 2005: 291). Caries along the cervico-enamel line, or root surface caries, occur along the neck of the tooth, at the junction where the root meets the enamel (Hillson 2005: 292). Gross caries are so large that the site of origin could not be determined (Hillson 2005: 292).

5.3.1b Dental Calculus

Presence or absence of dental calculus was recorded. When present, calculus was recorded as a small, moderate or heavy amount (Buikstra and Ubelaker 1994; Dobney and Brothwell 1987, Goodman *et al*., 1984; Hillson 2005). These categories were defined based on the amount of calculus present on each individual tooth (Buikstra and Ubelaker 1994; Dobney and Brothwell 1987, Goodman *et al*., 1984; Hillson 2005). While there are issues with this method in that results can be specific to a particular archaeological site, there are currently no means of standardizing severity of calculus, and indeed many other health indictors across Mesoamerica (Vance 2014: 87 Jacobi and Danforth 2002).

5.3.1c Dental Abscesses

Dental abscesses were recorded as either present or absent based on visual inspection and not the use of x-rays or other imaging techniques. If an abscess was present, measurements were taken with digital callipers and the size of the abscess was recorded.

5.3.1d Linear Enamel Hypoplasia (LEH)

Presence or absence of linear enamel hypoplasia (LEH) was recorded. If only barely discernible lines of LEH were present, the condition was recorded as slight. If there were multiple clear lines of LEH, the condition was recorded as severe. The number of lines of enamel hypoplasia was also recorded for the affected teeth; for example, a tooth exhibiting severe indicators might have three distinct lines of hypoplasia (Hillson 2005).

5.3.2 Porotic Hyperostosis

Porotic hyperostosis was recorded through the careful visual examination of the external surfaces of the cranial vault, most often noted on the frontal, parietal and occipital bones. Porotic hyperostosis was scored as either absent or present, and when present as slight, moderate (Figure 5.2), or severe. All scores were based on the presence and severity of porosity (Table 5.5) (Buikstra and Ubelaker 1994: 120-121; Wright and Chew 1998).

Figure 5.2: Example of moderate porotic hyperostosis on parietal fragment from Nojol Nah, photo by author.

Table 5.5: Scale of porosity

Slight	Indistinct pores
Moderate	True porosity
Severe	Coalescing pores

It should be noted that these methods, although frequently used in osteological analyses, can often be subjective. This is true not only for porotic hyperostosis and cribra orbitalia but also for linear enamel hypoplasia. Difficulties therefore arise when trying to draw comparisons between and among sites (Wright and White 1996). For the northern Three Rivers Region study the term 'severe' is used to describe the most serious cases of porotic hyperostosis and cribra orbitalia within the northern Three Rivers Region populations (cases of coalescing pores only), but there are no cases of coalescing pores with other expansive changes and thus the cases in the study may not be considered as 'severe' in regards to some other skeletal populations, because, as with calculus, the scoring of severity can be specific to the skeletal population of a particular archaeological site.

5.3.3 Cribra Orbitalia

Right and left eye orbits were scored for cribra orbitalia based on presence and severity of porosity (Figure 5.3). The same scale used to assess porotic hyperostosis (Table 5.5) was used to assess cribra orbitalia (Buikstra and Ubelaker 1994).

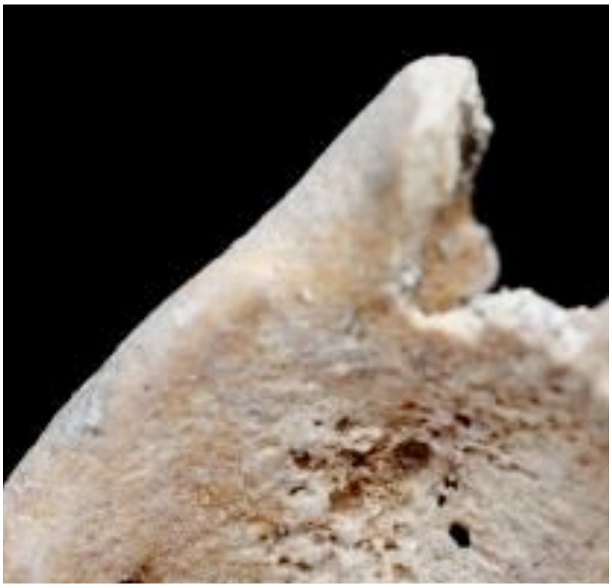

Figure 5.3: Example of 'severe' cribra orbitalia from Nojol Nah (NN-TM-6). Photo courtesy of the Maya Research Program, 2013.

5.3.4 Osteoarthritis and Degenerative Joint Disease (DJD)

Indicators of degenerative joint diseases were scored as either absent or present based on three levels of severity (slight, moderate, severe) (Table 5.6) (Bridges 1992; Jurmain and Kilgore 1995; Waldron 2009). In instances of burials containing multiple individuals, osteoarthritis at times was implemented as a way to distinguish between sets of skeletal remains.

Table 5.6: Scale of DJD and osteoarthritis.

Slight	Beginning of lipping on edges of the articular surface(s).
Moderate	Clear lipping on edges of the articular surface(s). Signs of porosity on the bone.
Severe	Substantial lipping on edges of the articular surface(s); Clear porosity on the bone.

5.3.5 Skeletal Trauma and Lesions

Skeletal trauma and potential complications were recorded (Buikstra and Ubelaker 1994; Ortner 2011; Sauer 1998; White and Folkens 2005). Fractures were recorded by type, location, and severity (Buikstra and Ubelaker 1994). In a few instances, osteomyelitis secondary to fracture was evident on the bone and, if present, then its location, size and type were recorded (Buikstra and Ublelaker 1994).

5.4 Skeletal Modifications

Many early studies of Maya skeletal modification focused on description and classification of modifications and the distribution of these classes between and within populations. There are two distinct types of skeletal modification found in Mesoamerica, cranial and dental modifications, and these can have many subtypes, each of which can be classified based on form. The methods employed identified the presence or absence of cultural modification to the skeleton and assigned each modification based on published typologies (Tiesler 1999; 2010; 2013; Williams and White 2006). While classification of modifications will be undertaken here, the association between skeletal modification and health indicators are the primary focus of analysis.

5.4.1 Cranial Modifications

A number of individuals in the northern Three Rivers Region study exhibit cranial modification (for an example see Figure 5.4). Where possible, metric methods were used to determine presence and type of modification. Circumference and measurement from glabella to bregma, and the midcoronal were taken to attempt a determination of tabular oblique, or tabular erect -- fronto-occipital flattening (Tiesler 2010: 293). If the modification proved to be ambiguous and could not be distinguished, for example, if only small fragments of the cranium were present but exhibited evidence of modification -- then simply presence of modification was recorded.

Figure 5.4: Frontal view (left) and lateral view (right) of a fronto-occipital modified cranium (NN-TM-6). Photos courtesy of the Maya Research Program, 2012

5.4.2 Dental Modifications

The classification of dental modification follows the Romero Molina (1970) system of typology (refer to Chapter 3, Figure 3.4). Even though this is not a comprehensive diagnostic system--as other variants of dental modification have been created since the Molina system was designed--it remains the most comprehensive system of classification for Mesoamerican dental modification and continues to set the standard for classification in this region (Geller 2006; Verisani *et al*., 2011: 1002). The Molina system comprises seven different basic typologies of dental alterations, which are further subdivided into separate styles (refer to Figure 3.4 and see Figure 5.5 for examples from Nojol Nah and Xnoha). The resulting fifty-nine variants are classified, as explained by Verisani *et al*., (2011: 1002) ‘in accordance with the nature of the alteration of the crown contour, the inclusion of decorative details on the buccal surfaces or a combination of both.’

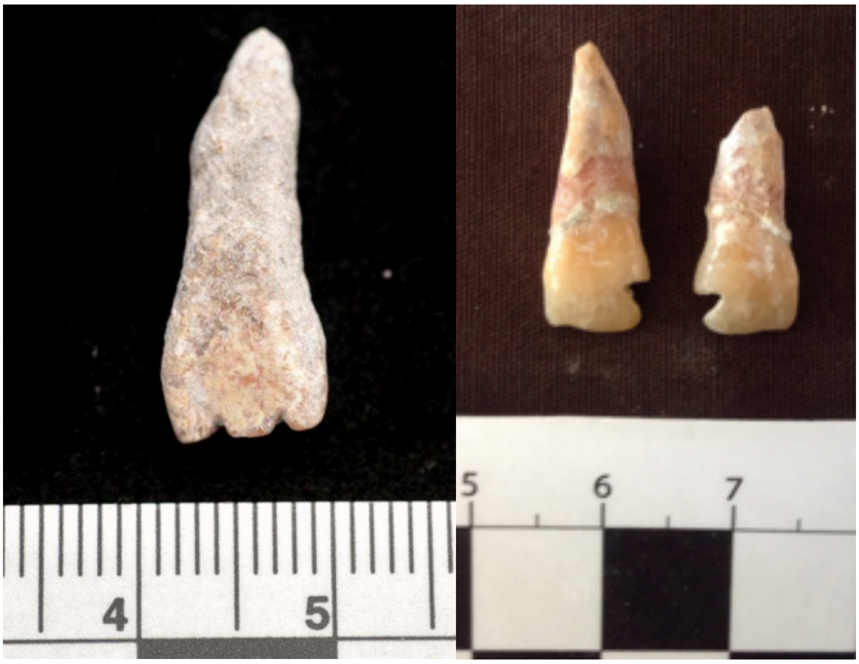

Figure 5.5: (Left) example of dental modification type A2 (NN-44). (Right) upper central incisors in type B4 (XO-14-13); photos by the author.

5.5 Statistical Analysis

With a total of 222 individuals and 1095 teeth, the dataset was fairly large in terms of both osteological and dental samples in Mesoamerica (Geller 2012c; Spence and White 2009; Wright 2006); however, in the context of running statistical tests, the dataset was too small to allow for complex tests to be explored. Statistical analyses were conducted using the complete dataset, and also for each skeletal population of the individual sites. All results were considered to be significant if they were at a confidence level of p= 0.05 (95%).

The statistical software used for the completion of this research was IBM SPSS version 22. The data produced by the osteological assessment undertaken in this project were either nominal or categorical, and thus non-parametric tests were used. While it would have been useful to run Chi Square tests, the dataset was too small for any Chi Square test to have been accurate; the assumptions entailed when preforming chi square tests would have been too large and the available data too few (Field 2013: 724). Fisher's Exact tests, cross-tabulations, and frequencies were used. Fisher's Exact tests allow smaller sample sizes to be statistically tested, while descriptive statistical tests like cross-tabulations can compare frequencies across or between groups (Field 2013: 723-724). These allowed for smaller sample sizes to be compared with greater viability rather than if Chi Square tests had been used.

Chapter Six

Sex and Age-at-Death: first steps towards a Population Demography

Biological sex ratios and age at death can help to deliver a clearer and more concise picture of a community. An understanding of the population must first be sought, prior to formulating any hypothesis or conclusions in regards to any given study population. The importance of the role of palaeodemographics within the larger study of archaeology is an idea that has been explored since the 1970s and biological sex and age at death are componants of population demography they will be explored within this chapter (Acsadi and Nemeskeri 1970; Storey 1992: 22; Weaver 1998: 37; Wood *et al.,* 1992). Even in areas such as the Maya lowlands, where issues in preservation often complicate osteological analysis, palaeodemographics can still assist in yielding information about past cultures and health indicators, even with very fragmented remains (Storey 1992: 23). In terms of osteological study, 'population demography' entails the assessment of biological sex and age at death for an entire population, not simply at the individual level (Acsadi and Nemeskeri 1970).

In this chapter, biological sex and age at deaht of the three study sites is presented. First, all three sites will be considered together; then the three sites, Blue Creek, Nojol Nah, and Xnoha, will be examined individually. Each section has a similar template in describing the demographics for each population so that the information can be presented in a consistent and clear manner. As this research is both a cultural and biological study, the time periods from which the skeletal samples date is also addressed within this chapter in order that a thorough understanding of the region's communities can begin to be obtained.

6.1 Population Demography of the northern Three Rivers Region

In this section, the daiting of the skeletal sample will be considered first, followed by biological sex ratios, and age-at-death. These topics are examined to provide a sharper picture of the demographics of the region prior to moving onto the issues regarding health and disease in the area. For a complete list of biological profiles for the entire skeletal population refer to Appendix A.

Due to a multitude of factors, including high pH levels of the soils, excavator error, damage due to taphonomic process and burial practices which resulted in the disturbance of primary burials at a later date, not a single individual within the sample was found to be complete. Levels of incompleteness varied immensely throughout the dataset. While several samples were found to be nearly complete, in many cases individuals were represented only by a few fragments (Table 6.1).

Table 6.1: Preservation among all three study sites.

		Site			Total
		Blue Creek	Nojol Nah	Xnoha	
Preservation	Excellent >75%	3	16	2	21
	Good 50-75%	9	23	5	37
	Fair 25-50%	18	24	7	49
	Poor <25%	66	29	20	115
Total		96	92	34	222

6.1.1 The Dating of the Skeletal Sample

The Maya inhabiting this area of northern Belize (as discussed in Chapters 2 and 4) had an occupation period spanning the Middle Preclassic through the Terminal Classic period, a time frame of about 1700 years. Parts of the Blue Creek polity, such as Chan Cahal, are among the earliest occupations recorded in northern Belize (Beach *et al*., 2014: 3). Areas near the northern Three Rivers Region were still flourishing at the time of Spanish contact in the 1500s. At the Coastal Plain site of Lamanai, about 36 kilometres southeast from Blue Creek, the city was densely populated at the time of Spanish contact (Graham 2011; Masson 2002). The occupation of Blue Creek, Nojol Nah, and Xnoha extend into the Terminal Classic period but by the time of the Spanish conquest they had been abandoned.

The Late Classic (as evidenced by Tepeu 2-3 ceramics) had the densest population levels per square kilometre for the occupation periods of the Three Rivers Region (Sullivan 2002: 201). The data presented here however show the highest number of burials within this assemblage date to the Early Classic (Figure

6.1). However, much of this may be due to excavation choices and burial preservation which can create an unintended bias.

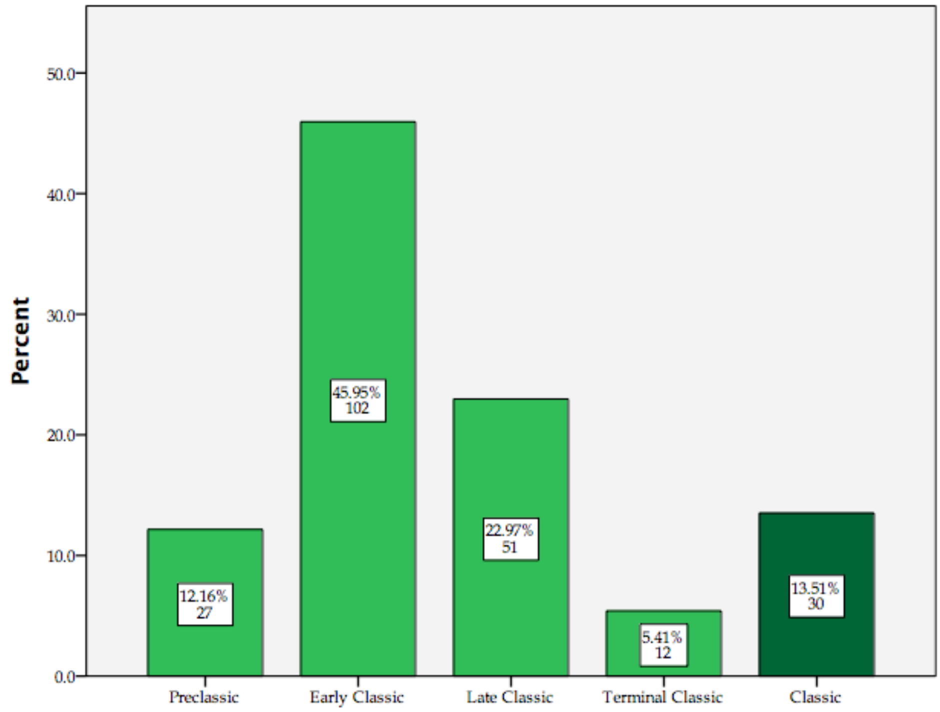

Figure 6.1: The complete skeletal population through time. The general 'Classic' bar is comprised of those individuals whose burial information did not offer enough material to date to a more specific time period, other than the Classic Period.

6.1.2 Biological Sex in the northern Three Rivers Region

Table 6.2: Biological sex for the complete dataset.

	Frequency	Percent
Male	64	28.8
Female	43	19.4
Immature	30	13.5
Indeterminate	85	38.3
Total	222	100.0

Table 6.3: Biological sex in each study site.

Biological Sex		***Blue Creek***	***Nojol Nah***	***Xnoha***
Male	Count	25	24	15
	Percent	26.0	26.1	44.1
Female	Count	10	28	5
	Percent	10.4	30.4	14.7
Immatures	Count	10	13	3
	Percent	10.4	14.1	8.8
Indeterminate	Count	51	27	11
	Percent	53.1	29.3	32.4
Total	Count	96	92	34

Of the 222 individuals studied there were 85 (38.3%) to which biological sex could not be estimated (Tables 6.2 and 6.3). In addition, immatures (N=30) cannot have biological sex confidently assigned, leaving another 13.5% of the total skeleton population unassigned. Of the 107 individuals that did provide diagnostic material for analysing biological sex, 64 (28.8%) were estimated to be male and 43 (19.4%) were estimated to be female.

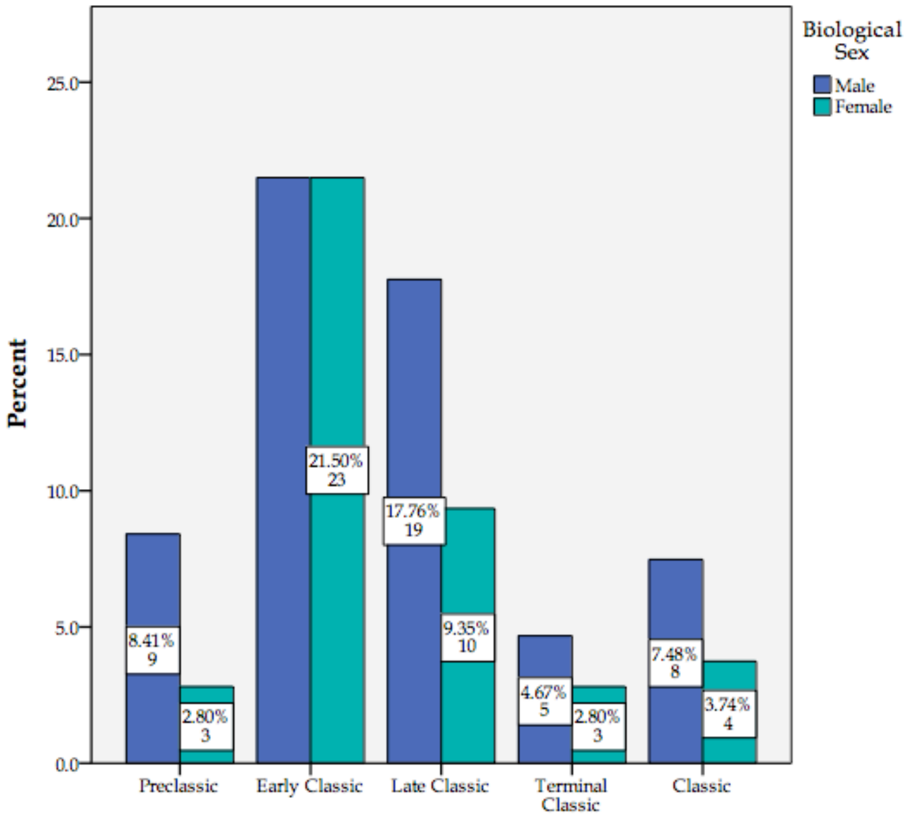

Figure 6.2: Biological sex ratios through time in the northern Three Rivers Region.

Figure 6.2 shows the ratios of male and female skeletons through time. The outcome of percentages of males and females for each of the time periods is as expected for the Maya region. Due primarily to osteological sexing methods, there is a 'consistent bias' toward the overrepresentation of male skeletons in many Maya skeletal assemblages (Wright 2006: 30). Shifting social groups and residence post-marriage may also have been a contributing factor to the prominence of male skeletal remains (Wright 2006: 30). Whatever the reasons, aside from the skeletons dating to the Early Classic, a period in which males and females are found in equal ratios, this common bias toward the preponderance of male skeletons, which is seen throughout the Maya region, is also observed in the northern Three Rivers Region skeletal sample.

6.1.3 Age at Death in the Three Rivers Region

Most of the adult skeletal population could not be aged due either to the state of preservation or the lack of indicator skeletal materials, and have been placed into the general age group of 'adult' (Figure 6.3 and Table 6.2). The second largest category was that of 'middle adult' (thirty-five to fifty years). For this region during the time periods being examined, having a large middle adult sample is characteristic (Sullivan 2002).

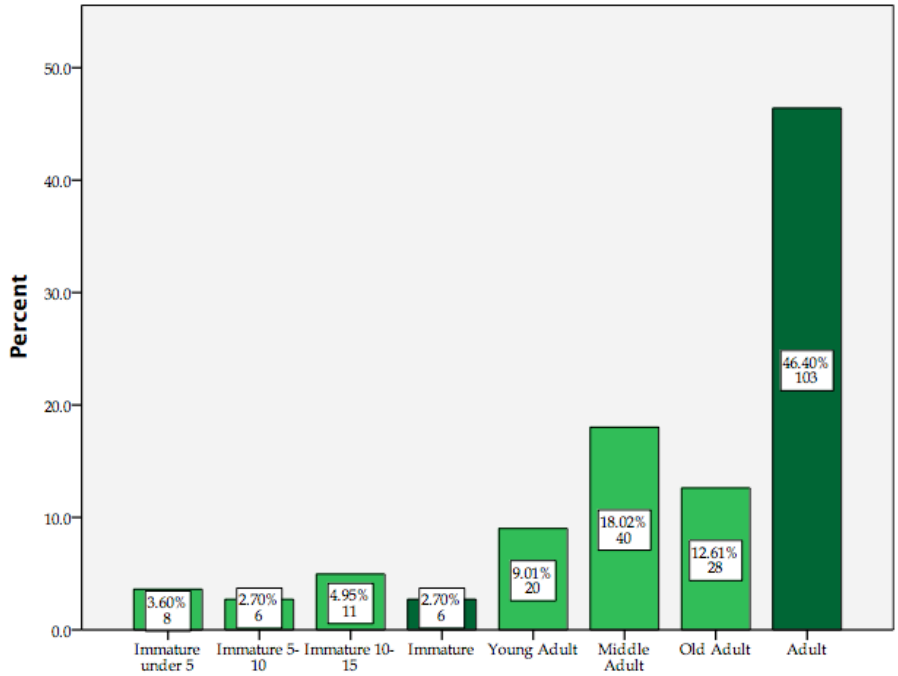

Figure 6.3: Age at death for the northern Three Rivers Region, skeletal series. The general 'Immature' and 'Adult' categories which could not be assigned a more specific age range are presented in a darker shade.

Of the total study sample, it is important to note the small percentage of immature remains present. Individuals in the age group <5 years make up 3.6% of the entire study population and 5-10 year olds comprise 2.7% of the sample (Table 6.3). The low prevalence of children could be either due to poor preservation of skeletal remains in the region (see Chapter 3), or it could be related to issues in archaeological recovery, as infant and young child bones can be difficult to recognize and so often missed in the excavation process or confused with faunal remains or buried elsewhere and are simply not being excavated.

Out of the 30 immature individuals in the northern Three Rivers Region study about a third were found in the contexts of double burials (n=11), most often with an adult (83.5%); occasionally two immatures were buried together. Thus, an alternative reason for the small percentage of immature remains could be that burials of infants and children were not as often interred within spaces typical for adult burials. For example, there are many instances of non-adult remains being found in caves (Rue *et al*., 1989). At Teotihuacán, infant burials are frequently found in large ceramic vessels in the context of altars, and there are instances of Preclassic and Classic Maya practicing this custom as well (Hedrick 2009). For example, the Blue Creek skeletal population includes one infant burial (BC-Cache-2) found *in situ* within a large ceramic vessel, as part of a burial cache within Structure 9 of the Blue Creek site core (Chapter 10.3.4).

It is likely that the issues are compounded and involved two or more of these causes to create such a small percentage. In Copán's Group 9N-8, 85% of the sub-adult population died before the age of five, which is typical for human populations worldwide and is due to issues in pregnancy, genetic problems and infection (Storey 1992: 164). The northern Three Rivers Region excavations focused on household groups, monumental architecture and plazas, and while this encompasses a great deal of Maya public and private spaces, there remains a chance that many burials of immatures are just not being excavated.

6.2 The Blue Creek Skeletal Population

Despite Blue Creek yielding a sample size of 96, only 35 sets of adult remains retained skeletal characteristics that can be used to estimate biological sex (36.4%; Table 6.2). Ten (10.4%) were immatures and therefore reliable biological sex could not be determined, while the preservation was such that 51 adults could not have biological sex assigned. Of the remaining 35, 25 (26.0%) were estimated to be male and 10 (10.4%) to be female.

Age demographics for Blue Creek are presented in Figure 6.4. Of the total individuals comprising the Blue Creek skeletal collection 63 (65.6%) could only be estimated to be 'adult'; again this is largely due to the effects of the taphonomic process as well as a general lack of diagnostically discernible skeletal elements. Of the skeletal remains which could be recorded to a more specific category, the majority were classified as 'Middle Adult.'

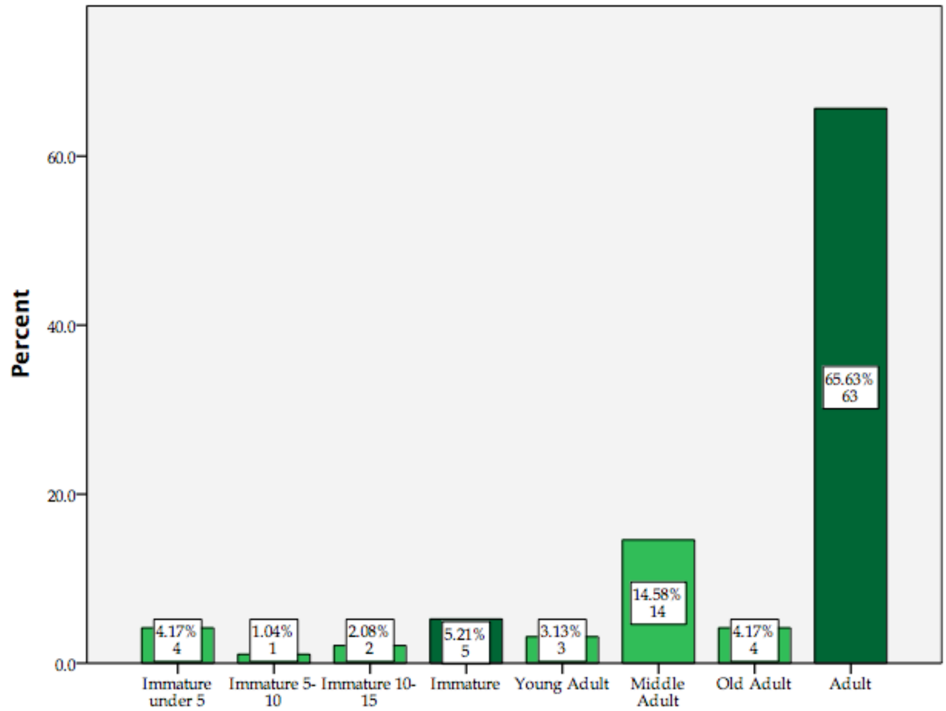

Figure 6.4: Frequency of age at death at Blue Creek.

6.3 The Nojol Nah Skeletal Population

Biological sex could confidently be assigned to 52 (55.4%) individuals within the Nojol Nah skeletal population (Table 6.4). This percentage is telling however, as of the three study sites on average, Nojol Nah yielded skeletal remains which were quite well preserved in relation to both of the other study sites, in particular with regards to the Blue Creek skeletal collection. Therefore, there were a couple of instances in which statistical analysis of the osteological data, when combined in crosstabs, could only be run for Nojol Nah; however, these instances were very few in number and are still included in the northern

Three Rivers Region study as they do provide insight into the health of the region (refer to Chapters 7 and 8).

Of the individuals who could be scored for biological sex, 24 (26.1%) were estimated to be male and 28 (30.4%) to be female (Figure 6.2). There were 40 individuals (43.4) for whom biological sex could not be estimated; however, 13 of these individuals were pre-pubescent immatures. The remaining sets of skeletal remains contained no indicative elements and so precluded sex evaluation.

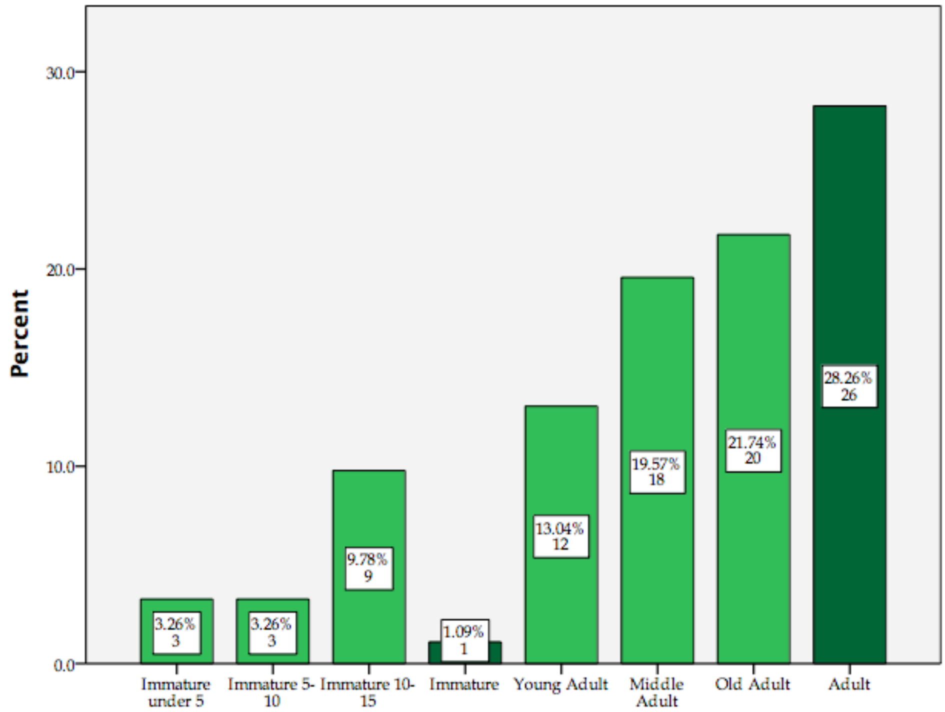

Figure 6.5: Frequency of age at death at Nojol Nah.

Age at death for the Nojol Nah skeletal population followed a normal attrition age-specific mortality profile expected for populations in the larger Three Rivers Region (Geller 2012). However, the immatures in the population did not. Expected curves for immature individuals have more immatures dying at a younger age, in infancy or weaning age, while this population has a high percentage of skeletal remains aged between 10 and 15 years at death. This could be due to preservation and other issues involving immature remains discussed in Chapter 3 and Section 6.1.4 of this chapter. While there were quite a few individuals who could not be scored beyond a general age of 'adult,' those individuals which could have narrower age estimates did fall in line with the overall population of the area.

6.4 The Xnoha Skeletal Population

Since excavations at Xnoha have not yet been as extensive as at the two other study sites, the sample size is comparatively small. Of the 34 human remains that comprise the Xnoha skeletal assemblage, 20 (58.8%) of these could be analysed for biological sex (Table 6.2). Of those 15 (44.1%) were estimated to be male, and only 5 (14.7%) female. Comprising 8.8% (n = 3) of the Xnoha skeletal population, immatures were not assessed for biological sex, and for 11 adult individuals (32.4%) biological sex could not be determined. Structure 79, yielded the highest quantity (N=7, 20.6%) of burials at Xnoha, and all 7 were estimated to be male.

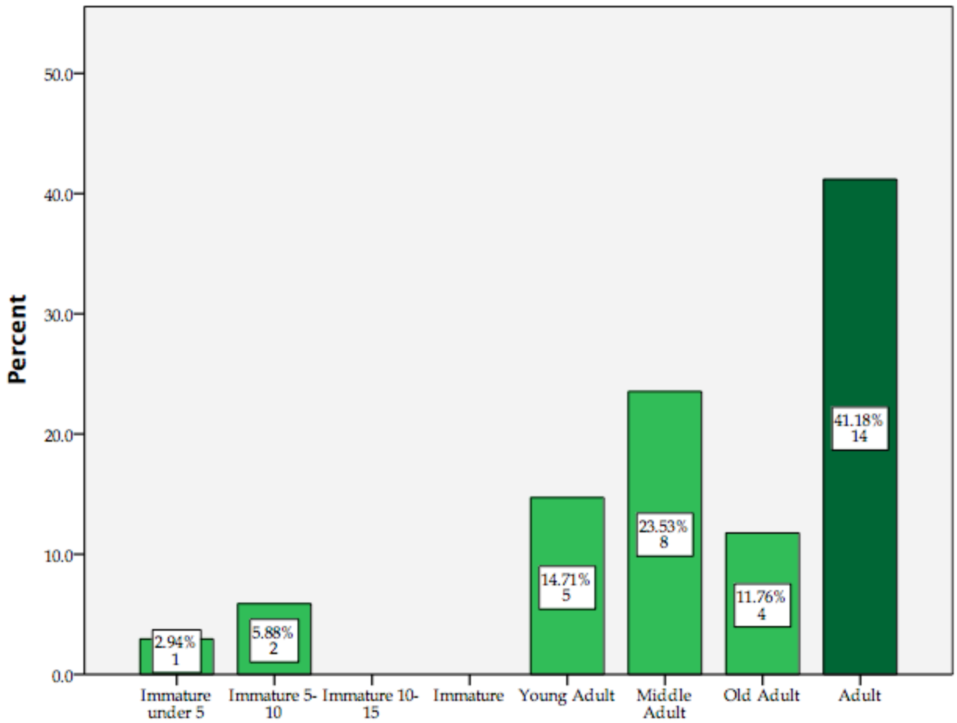

Figure 6.6: Frequency of age at death at Xnoha.

Nearly half of the Xnoha adult skeletal population could not be provided with a more clearly defined age category than 'adult' due to issues of preservation

(Figure 6.6). The skeletal population from Xnoha is interesting as the inhabitants occupied the site much later than at Nojol Nah and much of Blue Creek, although a number of burials did date to the Preclassic period. This is not to say that Xnoha was not occupied during the Middle Classic but simply that the burials excavated thus far date to the Preclassic and Late Classic periods and because of this long timespan, the rates of the health indicators seen at the site can really be examined through time, again, much like Blue Creek.

6.5 Biological Sex and Age at Death Results

The full understanding of the three distinct populations of the northern Three Rivers Region is intrinsic to the study of health within this region. A paleodemographic approach establishes biological sex and age at death ratios which supplies a richer platform for analysis and discussion while inherently negating issues related to sample bias. While the issues raised by Wood *et al.*, (1992) discussed in Chapter 3, are pressing, relevant, and must be considered, a strong palaeodemographic profile creates at least a slightly sturdier foundation for palaeoepidemiology. A population level of health analysis provides insight into the health of past societies.

This chapter presented the preliminary population demographics for the three study sites both combined and separately. Through the assessing of biological sex and age at death, this chapter is a necessary step in understanding the skeletal population of the northern Three Rivers Region. Biological sex is fairly represented in the study, with perhaps the greatest discrepancy in sex ratios being at Xnoha where 75% of the individuals analysed for biological sex were male and only 25% were female. However, within the overall skeletal assemblage of the northern Three Rivers Region the sexes are represented evenly. Futher discussion of paleodemographics will be addressed in Chapter 11. What follows is an in-depth exploration of health in the region and the various cultural factors that could have been affected by or have affected health in this corner of the Maya lowlands.

Chapter Seven
Dental Health Indicators in the Northern Three Rivers Region

This chapter comprises the results of analyses completed during the study that focused on dental health within and among the three study sites. What follows is an in-depth presentation and discussion of those results, at different levels: by tooth (as a proportion of total number of teeth within the dataset, a true prevalence rate) and per individual (as a proportion of the total number of dental arcades, a crude prevalence rate). Rates of dental pathology were compared between the sexes, and considered across the northern Three Rivers Region (the three sites combined) and by individual populations (Blue Creek, Nojol Nah, and Xnoha). Special attention is also paid to dental development and dental health in the immature population.

Dentition is one of the most informative areas of study in osteology, as teeth can provide a clear and diverse insight into an individual's, or a population's, lifeways: age, ancestry, diet, health, are just a few aspects that can be studied effectively through dental analysis (Cucina and Tiesler 2003; Cucina *et al*., 2003; Dobney and Goodman 1991; Hillson 1979, 2005; Liebe-Harkort 2012a, 2012b; Lieverse 1999; Lund 2003; Mickleburgh and Pagan-Jimenez 2012; Seidemann and McKillop 2007). Presented here are the results of dental analysis focused on illuminating diet and health in the northern Three Rivers Region. Prevalence of caries will be presented first, followed by calculus, enamel hypoplasia, antemortem tooth loss, periodontal disease, and dental abscesses.

7.1 The Dental Study Material

The combined adult population of all three study sites included a total of 118 individuals with some form of dentition present. This could be a complete dental arcade with teeth *in situ* within the jaws, or only a few loose teeth found in a grave context. These 118 individuals comprised a total of 1083 permanent teeth. The majority of the teeth came from the site of Nojol Nah (n = 754; 69.6%) whereas Blue Creek (n = 147; 13.6%) and Xnoha (n = 182; 16.8%) produced lower numbers of teeth. The anterior dentitions in particular were well represented within the dataset (Figure 7.1; Table 7.1).

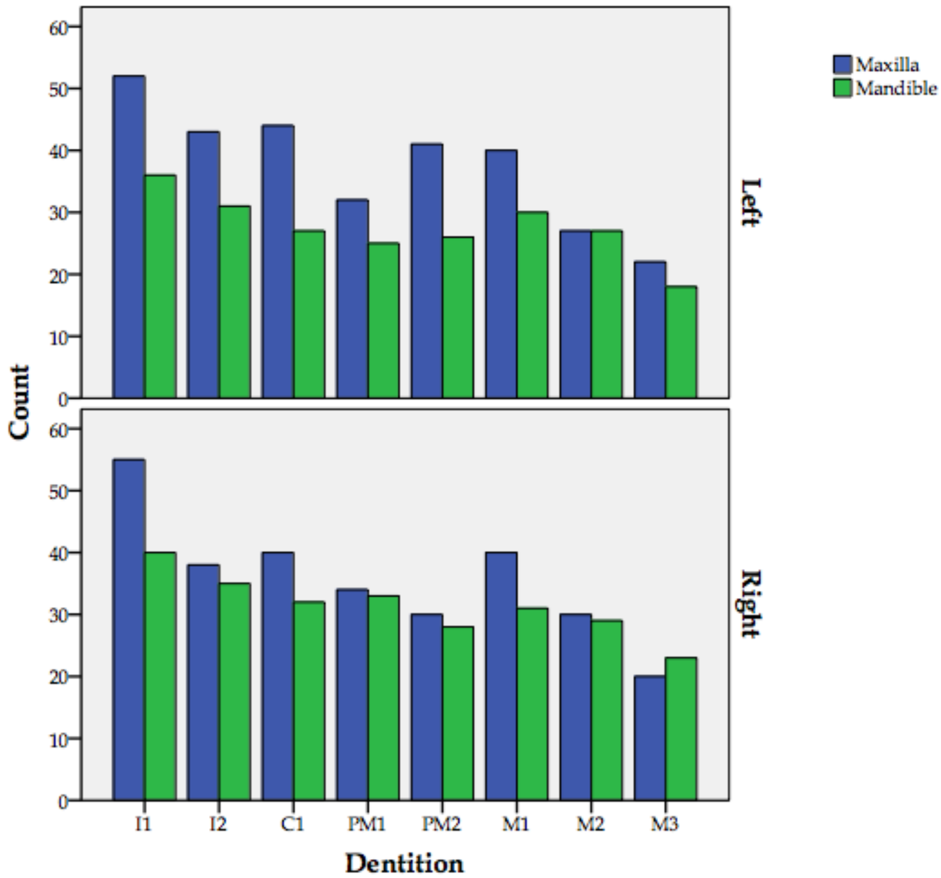

Figure 7.1: Distribution of teeth in the maxilla and mandible of the total adult dataset available for study.

Table 7.1: Dentitions of the total adult dataset. Presenting frequency of each tooth type in maxilla and mandible.

		Maxilla		Mandible	
		Left	Right	Left	Right
		Count	Count	Count	Count
Dentition	I1	52	55	36	40
	I2	43	38	31	35
	C1	44	40	27	32
	PM1	32	34	25	33
	PM2	41	30	26	28
	M1	40	40	30	31
	M2	27	30	27	29
	M3	22	20	18	23
Total per side		301	287	220	251
Total per jaw		588		471	

7.2 Caries

This section presents the results of dental caries at all three sites. First examined are caries by tooth true prevalence rate (TPR), followed by an examination at the level of the individual dental arcade, or crude prevalence rate (CPR). Where possible, each of the other sections will follow this format. In cases of exceptions, explanations are given as to why presenting both forms of data was not possible.

7.2.1 Caries: Dentitions

Table 7.2: Frequencies of true prevalence of caries throughout the dataset.

	Frequency	**Percent**
None Observed	918	84.8
One	143	13.2
Two	16	1.5
Three	5	0.5
Four	1	0.1
Total	1083	100.0

Table 7.3: Crosstabulation showing frequencies of caries affecting teeth of the maxilla and mandible.

		Caries						**Total Teeth**
		None Observed	Total	One	Two	Three	Four	
Maxilla	Count	514	89	79	9	1	0	603
	Percent	56.0		88.76	10.11	1.12	0.00	55.7
Mandible	Count	404	76	64	7	4	1	480
	Percent	44.0		84.21	9.21	5.26	1.32	44.3
Total Records	Count	918	165	143	16	5	1	1083

Caries were observed on a total of 165 (15.3%) teeth (Table 7.2). There were no significant differences observed between rates of maxillary versus mandibular caries in the dataset (chi square = 0.309; P = 1.00). Of the total maxillary teeth present (n = 603), carious lesions affected 89 teeth (14.76%), and of the total mandibular teeth (n = 480) 76 teeth (15.83%) were affected (Table 7.3 and Figure 7.2). For both maxillary and mandibular teeth, one caries per tooth was most frequently recorded (n = 143). The highest number of caries observed on a single tooth was four, and this only affected one mandibular first molar (NN-22, a middle adult female) (Figure 7.2).

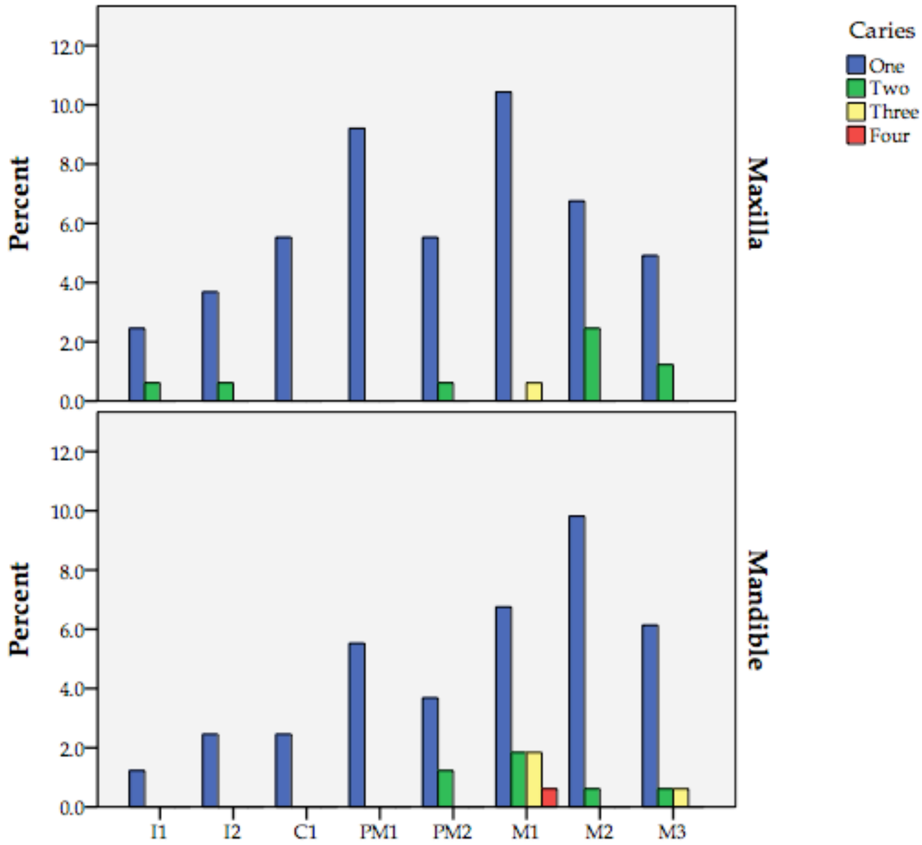

Figure 7.2: Percentage of true prevalence of caries per tooth in the northern Three Rivers Region.

Caries were observed across the northern Three Rivers Region (Table 7.4). At Nojol Nah the number of caries ranged from zero to four, at Blue Creek from zero to three and Xnoha, only had zero or one caries per tooth (Table 7.4). Thus, of the three sites, Nojol Nah suffered from the highest numbers of caries per tooth.

Table 7.4: Caries per tooth at all three sites.

			Site			
			Nojol Nah	Blue Creek	Xnoha	**Total**
Caries	None Observed	Count	613	129	176	918
		Percent	81.3	87.8	96.7	84.8
	Total	Count	141	18	6	165
		Percent	18.7	12.2	3.3	100.0
	One	Count	123	14	6	143
		Percent	16.3	9.5	3.3	13.2
	Two	Count	13	3	0	16
		Percent	1.7	2.0	0.0	1.5
	Three	Count	4	1	0	5
		Percent	0.5	0.7	0.0	0.5
	Four	Count	1	0	0	1
		Percent	0.1	0.0	0.0	0.1
Total Teeth		Count	754	147	182	1083

True prevalence rates of caries in males and females in the entire northern Three Rivers Region assemblage were compared to examine any sex specific patterning. Of the 931 teeth that could be assigned to a biological sex through the association of male and female skeletal remains, 531 (57.0%) were male and 400 (43.0%) were female.

Of the total Nojol Nah population (n = 92) 35 adults could be assigned a biological sex and had dentition present and at Blue Creek, 21 individuals from a total of 96 with present dentition could also be analysed for biological sex. With the Xnoha population analysis of caries by sex could not be completed, because there is only one known female burial within that skeletal assemblage with dentition. There was no significant difference in rate or severity of carious lesions between the sexes for the complete dataset (Fisher's Exact test F = 2.327; p = 0.522).

Table 7.5: Number of caries and biological sex among the complete dataset

			Biological Sex		Total
			Male	Female	
Caries	None Observed	Count	466	322	788
		Percent	59.1	40.9	
	Total Caries	Count	65	78	143
		Percent	12.2	19.5	15.4
	One	Count	55	69	124
		Percent	84.62	88.46	
	Two	Count	7	7	14
		Percent	10.77	8.97	
	Three	Count	3	1	4
		Percent	4.62	1.28	
	Four	Count	0	1	1
		Percent	0.0	1.28	
Total Teeth		Count	531	400	931
		Percent	57.0	43.0	

7.2.2 Caries: Dental Arcades

Of the 118 individuals with dentition preserved, almost half, 45.8% (n = 54) exhibited at least one carious lesion (Table 7.6). Therefore, at nearly half of the available dental population, caries were the most frequently observed health indicator in the study.

Table 7.6: Incidences of caries across the complete dataset, crude prevalence rate.

Caries present	Frequency	Percent
One or more	54	24.3
None observed	64	28.8
Total	118	53.2
Unobservable	104	46.8
Overall Total	222	100.0

Table 7.7: Crosstabulation of caries and biological sex at all three sites, crude prevalence rate.

			Caries		
			Caries Present	None Observed	**Total**
Blue Creek	Male	Count	5	11	16
		Percent	31.3	68.8	
	Female	Count	2	1	3
		Percent	66.7	33.3	
	Total	Count	7	12	19
		Percent	36.8	63.2	
Nojol Nah	Male	Count	15	8	23
		Percent	65.2	34.8	
	Female	Count	15	11	26
		Percent	57.7	42.3	
	Total	Count	30	19	49
		Percent	61.2	38.8	
Xnoha	Male	Count	6	4	10
		Percent	60.0	40.0	
	Female	Count	0	2	2
		Percent	0.0	100.0	
	Total	Count	6	6	12
		Percent	50.0	50.0	
Total	Male	Count	26	23	49
		Percent	53.1	46.9	
	Female	Count	17	14	31
		Percent	54.8	45.2	
	Total	Count	43	37	80
		Percent	53.8	46.3	

An individual was noted as having caries present as long as there was at least one tooth in the dental arcade which had suffered from caries. The largest sample of both dentitions with caries came from Nojol Nah. There were a total of 49 cases at

Nojol Nah in which adult dentition was present and both crude prevalence of caries and biological sex could be ascertained (Table 7.7). There is no significant difference in crude prevalence of caries between males and females when all three sites are considered together (Fishers Exact 0.590; p = 0.770) (Table 7.7).

Table 7.8: Crosstabulation of frequencies of caries through time in the northern Three Rivers Regior crude prevalence rate.

			Caries		Total
			Present	Absent	
Time Period	Preclassic	Count	4	8	12
		Percent	7.4	12.5	10.2
	Early Classic	Count	29	20	49
		Percent	53.7	31.3	41.5
	Late Classic	Count	14	21	35
		Percent	25.9	32.8	29.7
	Terminal Classic	Count	3	3	6
		Percent	5.6	4.7	5.1
	Classic	Count	4	12	16
		Percent	7.4	18.8	13.6
Total		Count	54	64	118

As with the true prevalence rate of frequency of caries, frequencies of rates of caries at the level of the individual illustrated that there was no significant difference in caries through time (chi-square = 0.108; p =0.518). Therefore, rather than any significant difference in frequencies of caries though time, rates of caries in this region seem to have been stable (Table 7.8). Conditions that fostered such stability will be discussed further in Chapter 11.

7.3 Calculus

7.3.1 Calculus: Dentitions

Of the 1083 teeth, 144 (13.3%) exhibited signs of calculus (Table 7.9). Calculus was scored as slight, moderate, and severe. Results for calculus prevalence will be discussed first per tooth, true prevalence rate, followed by instances of calculus per individual, crude prevalence rate.

Table 7.9: True prevalence rate of calculus among the complete dataset.

	Frequency	**Percent**
Slight	56	5.2
Moderate	52	4.8
Severe	36	3.3
Total	144	13.3
None Observed	939	86.7
Total	1083	100.0

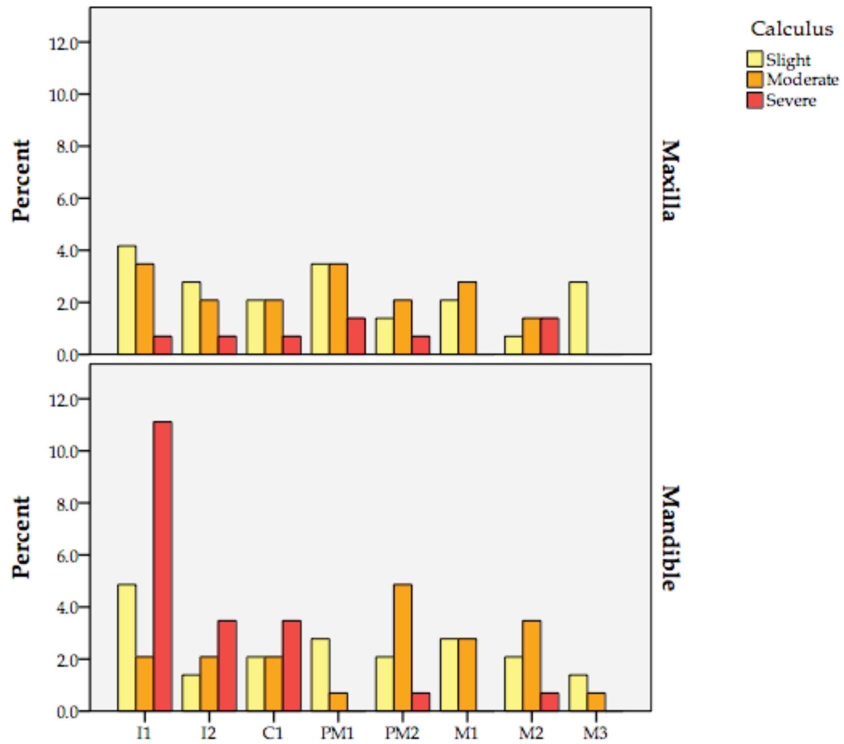

Figure 7.3: Percentage of true prevalence of calculus among the complete dataset.

Of the 144 (13.3%) teeth affected by dental calculus there were 56 (38.9%) cases of slight calculus, 52 (36.1%) moderate cases, and 36 (25.0%) teeth exhibited severe cases of calculus (Table 7.9 and Figure 7.3). Calculus affected both maxillary and mandibular dentition and was particularly prevalent on anterior teeth (Figure 7.3). The maxillary dentition had a fairly even distribution of calculus across the dentitions, however in the mandibular dentition, calculus was more frequent on the anterior teeth, especially the lingual sides of the central incisors (Figure 7.3). While the maxillary cases of severe calculus were distributed fairly equally across the maxillary dentitions (Figure 7.3), mandibular severe cases largely affected the incisors and canines (Figure 7.3), in fact, the majority of the severe cases (Table 7.10) were observed on the mandibular incisors.

Table 7.10: Crosstabulation showing frequencies of calculus affecting dentitions of the maxilla and mandible.

		Calculus				
		None Observed	Slight	Moderate	Severe	
Maxilla	Count	542	28	25	8	603
	Percent	57.7	50.0	48.1	22.2	55.7
Mandible	Count	397	28	27	28	480
	Percent	42.3	50.0	51.9	77.8	44.3
Total	Count	939	56	52	36	1083

Table 7.11: True prevalence of calculus by site

			Site			Total
			Nojol Nah	Blue Creek	Xnoha	
Calculus	None Observed	Count	634	133	172	939
		Percent	84.1	90.5	94.5	86.7
	All	Count	120	14	10	144
		Percent	15.92	9.52	5.50	13.30
	Slight	Count	41	10	5	56
		Percent	5.4	6.8	2.7	5.2
	Moderate	Count	49	2	1	52
		Percent	6.5	1.4	0.5	4.8
	Severe	Count	30	2	4	36
		Percent	4.0	1.4	2.2	3.3
Total Teeth		Count	754	147	182	1083
		Percent	69.62	13.57	16.81	

If the total rates of calculus per tooth are subdivided into the three separate sites, it can be seen that Nojol Nah has a total of 120 affected teeth (15.9%), Blue Creek has 14 (8.16%), and Xnoha 10 (4.14%) affected teeth (Table 7.11). Differences in the frequencies of calculus for each site per tooth at each site were found to be statistically significant ($F = 10.290$; $p = 0.026$). While the implications of these results will be discussed in Chapter 11, it should be noted that the results show that Nojol Nah had the highest number of affected teeth of the three sites. That the dentition at Nojol Nah was found to have the highest percentage of calculus could mean that the diet at Nojol Nah was slightly different than at Blue Creek or Xnoha; again, results will be discussed in further detail in Chapter 11.

Instances and severity of calculus at the level of the individual were examined, and it was found that severe calculus dominated the samples. If an individual had both slight and severe calculus present on the dentition, then the most severe was used in the statistical analysis. Out of the three sites Nojol Nah had the highest frequencies of severe calculus (Table 7.11). Nojol Nah also had the most cases of calculus overall at 15.9%, when compared with the other sites, with Blue Creek at 9.5% and Xnoha at 5.5% (Table 7.11).

The rates of calculus in relation to biological sex showed little difference in rates of severe cases of dental calculus between males and females. However, while instances of slight calculus were higher in males, there were more instances of moderate calculus amongst females. This result proved to be significant ($p<0.001$) meaning that there is a difference in severity of calculus between male and females. This could be caused by a slightly different diet or dental hygiene care between males and females in the northern Three Rivers Region (Table 7.12; Figure 7.4). As will be discussed in Chapter 11, differences in diet and dental hygiene between males and females is seen through frequencies of calculus as well as isotopically at a number of Classic Maya sites. Therefore, a slight difference in diet or dental care between males and females of the Three Rivers would not be out of the norm.

Table 7.12: True prevalence rate of calculus in relation to biological sex among the complete dataset.

			Sex		**Total**
			Male	Female	
Calculus	Slight	Count Percent	34 58.6	7 11.5	41 34.5
	Moderate	Count Percent	9 15.5	41 67.2	50 42.0
	Severe	Count Percent	15 25.9	13 21.3	28 23.5
Total		Count Percent	58 48.7	61 51.3	119

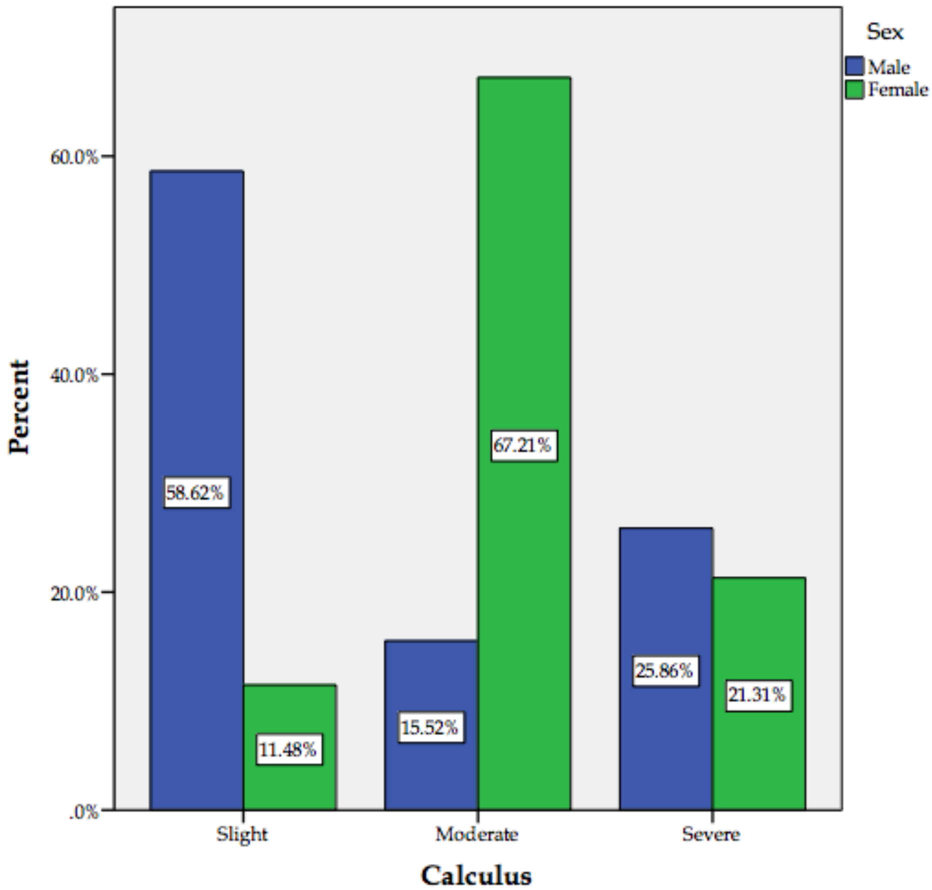

Figure 7.4: Rates of calculus according to biological sex at all three sites.

7.3.2 Calculus: Dental Arcades

Calculus observed at the individual level (CPR) is shown in Table 7.13. The majority of cases comprised heavy calculus. This is because if an individual exhibited dentition with more than one level of calculus severity, the more severe calculus was scored. All together there was a total of 22 adults with observable calculus, 5 from Blue Creek (5.2% of Blue Creek's total skeletal population), 13 from Nojol Nah (14.1%), and 4 from Xnoha (11.7%).

Table 7.13: Crude rates of calculus at all three sites.

			Calculus			Total
			Slight	Moderate	Heavy	
Site	Blue Creek	Count	1	1	3	5
		Percent	100.0	20.0	18.8	22.7
	Nojol Nah	Count	0	3	10	13
		Percent	0.0	60.0	62.5	59.1
	Xnoha	Count	0	1	3	4
		Percent	0.0	20.0	18.8	18.2
Total		Count	1	5	16	22

7.4 Periodontal Disease

Periodontal disease is the reabsorption of the alveolar bone into the mandible due to bacterial infection (see Chapter 3.5.1c). The eventual outcome is that the gum line recedes to the point where the tooth may be expelled, resulting in ante-mortem tooth loss (Chapter 3.5.1d). Periodontal disease is seen across all three of the sites used in this study. Of the total skeletal population, 120 (54%) had the skeletal elements necessary to observe presence or absence of periodontal disease. That is, either partial or full maxilla and/or mandibles were present for evaluation (Table 7.16). When an individual exhibited varied presentation of severity of periodontal disease, the most severe score was used in analysis. While 83.3% of individuals showed no signs of periodontal disease, 8.3% exhibited slight periodontal disease and 5.8% exhibited moderate (Table 7.14). There were just three (2.5%) severe cases of periodontal disease, all of which were found at Nojol Nah. Nojol Nah also had the highest percentage of caries of the three sites, and so with the development of carious lesions and poor overall dental hygiene, periodontal disease can develop. However, Nojol Nah also had the had the largest dataset by far out of the three sites, and this could also perhaps account for all three severe cases being from that site.

Table 7.14: Frequency of periodontal disease across the complete dataset.

			Site			Total
			Blue Creek	Nojol Nah	Xnoha	
Periodontal Disease	None Observed	Count	29	54	17	100
		Percent	90.6	78.3	89.5	83.3
	Slight	Count	2	7	1	10
		Percent	6.3	10.1	5.3	8.3
	Moderate	Count	1	5	1	7
		Percent	3.1	7.2	5.3	5.8
	Severe	Count	0	3	0	3
		Percent	0.0	4.3	0.0	2.5
Total		Count	32	69	19	120

7.5 Dental Abscesses

Severe consequences of dental caries and poor dental hygiene were observed in two of the skeletal remains, particularly in the form of abscesses, which form in the jaw in order to drain infection. Dental abscesses are severe outcomes of poor dental health. Therefore, while caries were seen in numerous instances throughout the skeletal sample, dental abscesses were observed in only two cases, one from Blue Creek and one from Nojol Nah, with one of those (NN-49) exhibiting two abscesses, on either side of the mental eminence, on the mandibular foramen of the mandible (Figures 7.5 and 7.6; see also Appendix A). These abscesses would have been the result of a build-up of infection, to the point were the infection became so great that the pressure would create an abscess in order to drain pus.

Figure 7.5: Large abscess on mandible of NN-49; photo courtesy of the Maya Research Program 2012

Figure 7.6: Two large abscesses on the mandible of NN-49; photo courtesy of the Maya Research Program 2012

7.6 Antemortem Tooth Loss (ATML)

Antemortem tooth loss was seen in a number of individuals in the northern Three Rivers Region. Most often it was the third or second molars that were missing although there were a few instances of other teeth missing. Due to the preservation of many of the maxillae and mandibles as well as the small sample size, statistical analysis of AMTL frequencies proved impossible.

7.7 Linear Enamel Hypoplasia (LEH)

Linear Enamel Hypoplasia (LEH) was observed on 68 teeth in total (6.3%). Severity ranged on a scale from slight to severe. Of the 68 teeth, 32 (47.1%) were observed as having slight cases of LEH, 36 (48.5%) as having moderate cases, and only 3 (4.4%) severe cases were observed (Table 7.15, Figure 7.7).

Table 7.15: True prevalence rate of LEH in the northern Three Rivers Region.

	Frequency	**Percent**
Slight	32	3.0
Moderate	33	3.0
Severe	3	.3
No LEH	1015	93.7
Total	1083	100.0

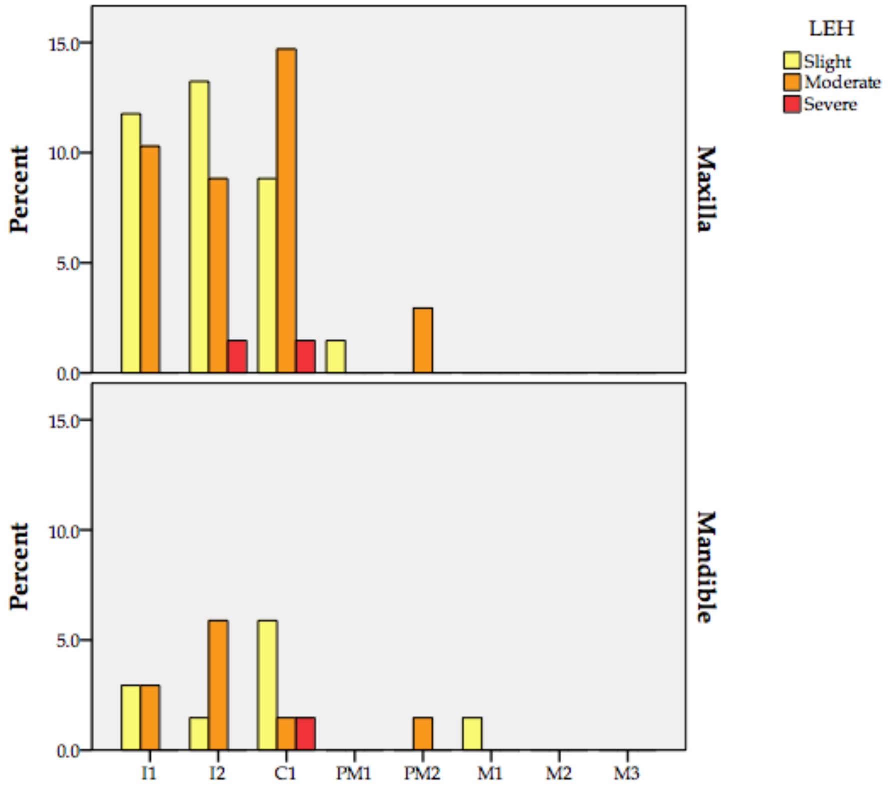

Figure 7.7: True prevalence of LEH among the complete dataset. 'Slight,' is indicative of a faint line of LEH, while 'Severe,' represents three clearly defined lines.

There was a significant difference in frequency of enamel hypoplasia between males and females overall among the three study sites (F = 8.302; p = 0.027) (Table 7.16). This is important because, as discussed in Chapter 3, enamel hypoplasia is quite informative in regards to childhood health (Wright and Yoder 2003). Enamel hypoplasia can reflect dietary differences between male and female children in this region. That is, these findings could be indicative of preferential treatment of one sex over the other in childhood in regards to diet within the northern Three Rivers Region. LEH is also caused by other factors such as long bouts of infection or fever, weaning stressors, and under- or mal-nutrition, and therefore the LEH present within this skeletal collection could have a variety of aetiologies.

Table 7.16: True prevalence rate of LEH among males and females in the complete dataset.

			Biological Sex		**Total**
			Male	Female	
LEH	None Observed	Count	505	377	882
		Percent	95.1	94.3	94.7
	Slight	Count	16	8	24
		Percent	3.0	2.0	2.6
	Moderate	Count	7	15	22
		Percent	1.3	3.8	2.4
	Severe	Count	3	0	3
		Percent	0.6	0.0	0.3
Total		Count	531	400	931

When the sample is divided according to the three sites (Table 7.17), there is no significant difference in rates of LEH. Regarding her work with the Pasión Maya skeletal assemblage, Wright (2006: 164) states that while there were many instances of enamel hypoplasia throughout the assemblage, there were very few severe cases. The same is true of this series from the northern Three Rivers

Region. For the Three Rivers Region, all three severe cases came from Nojol Nah. However, statistically there was no difference among the three sites and again the fact that all three cases were found at Nojol Nah could be in part due to the larger sample size of dentition from that site.

Table 7.17: True prevalence of frequencies and severity of LEH in the northern Three Rivers Region.

			Site			Total
			Nojol Nah	Blue Creek	Xnoha	
LEH	None Observed	Count	704	137	174	1015
		Percent	93.4	93.2	95.6	93.7
	Slight	Count	24	2	6	32
		Percent	3.2	1.4	3.3	3.0
	Moderate	Count	23	8	2	33
		Percent	3.1	5.4	1.1	3.0
	Severe	Count	3	0	0	3
		Percent	0.4	0.0	0.0	0.3
Total		Count	754	147	182	1083

The question of changes in rates of LEH through time is one which is often examined in Maya osteology (Seidemann and McKillop 2007; Scherer *et al.,* 2007; White 1999). Frequencies of LEH through time remained consistent in the northern Three Rivers Region skeletal population ($F = 9.842$; $p = 0.086$) with no large differences in LEH rates through time across the region (Table 7.18).

Table 7.18: True prevalence rate of LEH through time in the northern Three Rivers Region.

			LEH				Total
			None Observed	Slight	Moderate	Severe	
Time	Preclassic	Count	2	0	0	0	2
		Percent	100.0	0.0	0.0	0.0	
	Early Classic	Count	422	21	19	0	462
		Percent	91.3	4.5	4.1	0.0	
	Late Classic	Count	449	6	6	3	464
		Percent	96.8	1.3	1.3	0.6	
	Terminal Classic	Count	15	2	1	0	18
		Percent	83.3	11.1	5.6	0.0	
	Classic	Count	127	3	7	0	137
		Percent	92.7	2.2	5.1	0.0	
Total		Count	1015	32	33	3	1083
		Percent	93.7	3.0	3.0	0.3	

7.8 Dental Arcades: Supernumerary Dentition

In present day human populations, it is estimated that the frequency of supernumerary teeth, or hypertonia, range on a scale from 0.1% to as much as 3.6% (Duncan 2011: 584). In the northern Three Rivers Region study, supernumerary, or peg, teeth were found in 3 cases out of the 222 sets of skeletal remains (1.35%; Burials NN-24; NN-TM-6; and XO-15-02).

7.9 Dental Health among immatures in the northern Three Rivers Region

For the northern Three Rivers Region study, the dentition of immatures was analysed separately from the adult sample. This is due to a number of factors. First, the vast majority of the subadult dentition – all save for the dentition of one individual – came from Nojol Nah and its outlier site Tulix Muul. This could potentially skew the results of analysis performed on the three populations together. That is, if immatures had results markedly different from the adults it could bias the results of the adults; or, the results of the immatures might be hidden by the larger sample size of adults. Second, of the 222 total sets of skeletal remains, 30 are of immatures around 15 years old or younger at age at death. While dentition was not recovered from all 30, this sample provided an outlet to examine dental health in childhood separately from adults. Finally, a number of the immatures had both deciduous and permanent dentition, and because a focus of the northern Three Rivers Region study is to look at populations, the sample was divided not into permanent or deciduous dentition, but by individual dental arcade. As with the dentition of the adult population, the dentition of the immatures was well represented with both maxillary and mandibular teeth, and with many anterior dentition also being well represented within the sample (Figure 7.8).

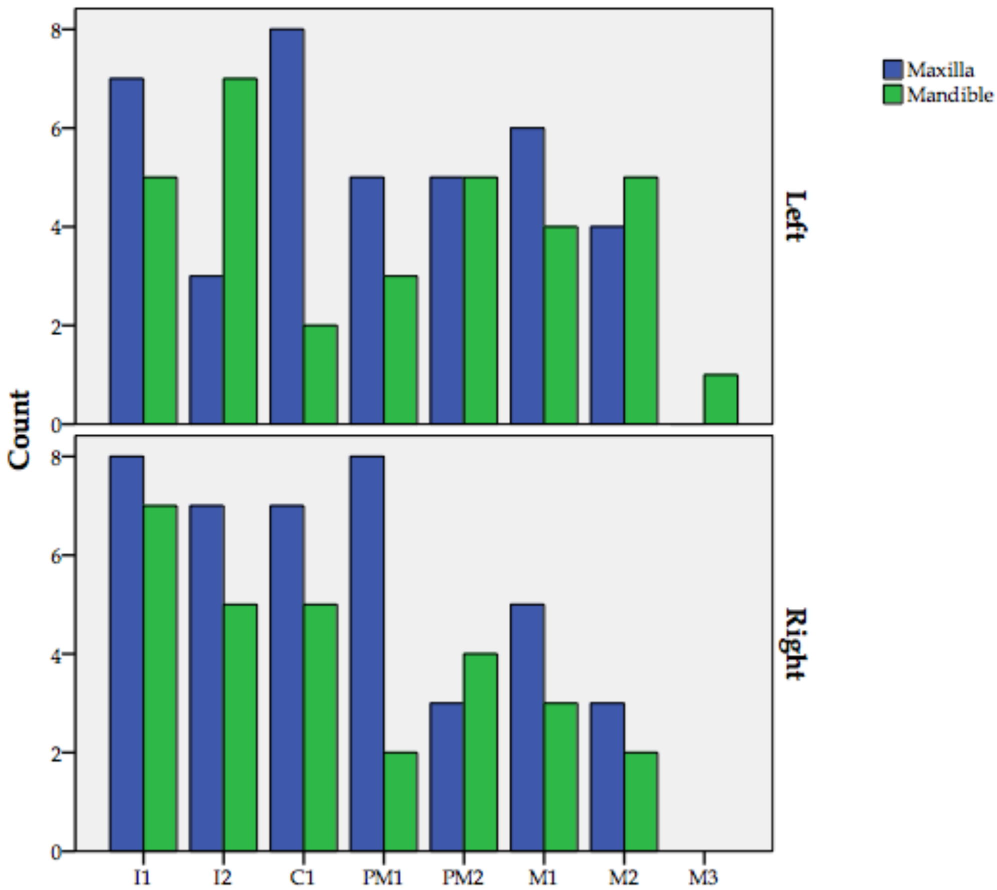

Figure 7.8: Distribution of teeth in the maxilla and mandible of the total immature dataset available for study.

Table 7.19: Dentitions of the total immature dataset.

		Maxilla		Mandible	
		Left	Right	Left	Right
		Count	Count	Count	Count
Dentition	I1	7	8	5	7
	I2	3	7	7	5
	C1	8	7	2	5
	PM1	5	8	3	2
	PM2	5	3	5	4
	M1	6	5	4	3
	M2	4	3	5	2
	M3	0	0	1	0

As with the adult dentitions, true and crude prevalence of caries and calculus will be examined in the immature dentition and considered by site, and over time. As immatures were not assigned a biological sex, it was not possible to consider prevalence of dental pathology by sex. Due to the young ages of these individuals as well as issues in preservation, there were no cases of periodontal disease observed.

A total of 142 individual teeth were recorded from immatures (Table 7.19). Of these 91.6 % (n = 130) come from Nojol Nah, while only 8.4% (n = 12) are from Blue Creek. Even though three sub-adult individuals were excavated at Xnoha no dental remains were recovered in association with these.

7.9.1 Immature Dentition: Caries and Calculus

Of the total 142 teeth only 9 (6.3%) exhibited caries (Table 7.20). Of these 9, all came from Nojol Nah. Only 1 tooth of the 142 exhibited calculus, this was also from Nojol Nah.

Table 7.20: True prevalence rate of caries, immature dentition.

	Frequency	Percent
None Observed	133	93.7
One	7	4.9
Two	1	0.7
Three	1	0.7
Total	142	100.0

7.9.2 Immature Dentition: Linear Enamel Hypoplasia (LEH)

Linear enamel hypoplasia was only observed on three of the 142 teeth, or 2.1%. These three teeth belonged to only two individuals, NN-TM-23, a sub-adult under the age of five had one tooth; and BC-AW-4, a juvenile between the ages of 12 and 15 had the two other teeth. These findings show that only 2.1% of juvenile dentition was affected by enamel hypoplasia. As will be discussed in further detail in Chapter 11, such a percentage is low in the Maya area. However, percentages vary quite a bit from site to site in the Maya lowlands.

7.10 Summary of Results

Presence or absence of dental pathologies are excellent indicators of diet and health. This chapter presented the results from the analysis of data on dental health in the northern Three Rivers region. These data were divided into adult and immature dentitions, analysed as both true and crude prevalence (by tooth, and by individual), and explored in combination with a series of additional variables: by site, sex and date.

Through analysis it was assessed that between sites overall there were no significant differences in frequencies of dental pathologies. This is also true when recording rates of dental pathologies through time, meaning that perhaps diet in the northern Three Rivers Region was fairly stable through time during the area’s occupation. However, when dental pathologies are analysed in relation to biological sex, significant differences arise, showing that males in the northern Three Rivers Region had significantly less dental pathologies than females, which suggests boys and girls may have been treated differently in terms of their diet. The following chapter, Chapter 8, presents the results on the skeletal health of the northern Three Rivers Region.

Chapter Eight

Skeletal Health Indicators in the Northern Three Rivers Region

This chapter presents the results of the skeletal (non-dental) analyses completed on the 222 individuals from the northern Three Rivers Region. Each section focuses on one particular pathology, and data are subdivided so that health across all three sites is presented first, followed by results from each of the three study sites considered separately. For a background on each of the pathologies examined in this chapter, refer to Chapter 3.

Firstly, metabolic bone diseases will be considered (degenerative joint disease, porotic hyperostosis, and cribra orbitalia), as well as osteomyelitis and periosteal reactions. Secondly, evidence of localised infections and trauma will be considered. Thirdly, there will be an account of nonmetric variations observed (spina bifida occulta, and sacralisation or lumbarisation of vertebrae). Finally, there will be a focus on two individuals (NN-15b and XO-14-05) whose results will be presented in greater detail as each has a number of separate health indicators that warrant further consideration.

8.1 Degenerative Joint Disease (DJD)

Table 8.1: DJD across the northern Three Rivers Region.

			Site			Total
			Blue Creek	Nojol Nah	Xnoha	
DJD	Overall	Count	7	20	3	30
		Percent	7.29	21.74	8.82	14.9
	Slight	Count	6	8	1	15
		Percent	85.7	40.0	33.3	50.0
	Moderate	Count	1	5	2	8
		Percent	14.3	25.0	66.7	26.7
	Pronounced	Count	0	7	0	7
		Percent	0.0	35.0	0.0	23.3
Total Individuals		Count	96	92	34	222

Table 8.1 shows rates of degenerative joint disease, omitting the cases where no signs of degenerative joint disease (DJD) were observed or data were unavailable. Of the total population of the northern Three Rivers Region sample (n= 222) thirty individuals (14.9%) exhibited indications of DJD. The overall rate of DJD at Nojol Nah was higher than at Blue Creek and Xnoha. More individuals displayed a slight form of DJD (n = 15; 50%) than either moderate (n = 8; 26.7%) or severe (n = 7; 23.3%) forms (Table 8.1). Of the seven cases with severe DJD, all were found at Nojol Nah, and will be considered in further detail below (Section 8.1.3).

The majority of individuals from the Blue Creek site did not show any evidence of DJD; of the minority that displayed DJD, 85.7%, showed only slight expression of disease (Table 8.1) Six of the seven individuals with DJD were male, while only one (BC-8) was female. Two of those affected were classified as 'Old Adult' (BC-AW-10 and BC-KT-J14D), four were classified as 'Middle Adult' while one could only be assessed as 'Adult'.

Of the total Nojol Nah skeletal population of 92, twenty individuals (21.7%) had DJD: eight had slight DJD, five moderate, and seven pronounced DJD (Table 8.1). However, almost half of the individuals did not show any evidence of DJD (n=72). Of the three study sites, only the Nojol Nah population provided a sample size which could be statistically tested to examine whether there was any significant difference in expression of DJD between males and females (Table 8.2).

Table 8.2: DJD and biological sex at Nojol Nah.

			Biological Sex		Total
			Male	Female	
DJD	Overall	Count	8	11	19
		Percent	42.1	57.9	36.5
	Slight	Count	4	4	8
		Percent	50.0	36.4	15.4
	Moderate	Count	1	3	4
		Percent	12.5	27.3	7.7
	Severe	Count	3	4	7
		Percent	37.5	36.4	13.5
Total Sample Available		Count	24	28	52

There was no significant difference between the sexes concerning DJD ($F = 0.766$, $p = 0.844$). Slight osteoarthritis was seen in four males and four females (Table 8.2). Moderate osteoarthritis was found in one male (NN-7) and three females (NN-9; NN-25; NN-TM-21) as well as one individual of indeterminate sex which is not listed in the table 8.2. Three males (NN-12a; NN-30, and NN-46) and four females (NN-4; NN-21b; NN-TM-6) exhibited severe cases of DJD.

Only three cases of osteoarthritis out of the total Xnoha population of thirty-four were observed during analysis (Table 8.1). A case of slight osteoarthritis was seen in burial XO-14-01, an adult male between the ages of thirty-five and fifty years. Two individuals exhibited moderate osteoarthritis (XO-4 and XO-14-08). XO-4 was an old adult female; she had moderate osteophytosis visible on the thoracic and lumbar vertebral bodies. XO-14-08, an older adult male, had moderate osteophytosis on the lumbar vertebrae. This individual also had undergone dental modification (Chapter 8.3.3).

8.2 Porotic Hyperostosis (PH)

Porotic hyperostosis is found widely throughout the Maya region of Mesoamerica (Scherer *et al.*, 2007; Storey 1998; Wright and Chew 1998; Wright and White 1996). These lesions manifest initially in children and frequently persist into adulthood. This portion of the study was undertaken in order to determine if there was a difference in diet or healthcare between male and female Maya children in this region.

Porotic lesions were scored into three groups based on the severity of the condition: slight, moderate, and severe (Chpater 5.3.5) Of the 222 study individuals, 132 had the cranial elements present necessary to conduct evaluation. Of these, the majority did not display evidence of porotic hyperostosis (85.6%; n = 113), whereas 4.5% (n = 10) presented some degree of porotic hyperostosis. Slight porosity was the most frequently observed state (Table 8.3). A severe case was seen in only one individual (BC-AW-5). This was an immature individual around 2 to 3 years. There were also six cases of moderate porotic hyperostosis, only one of which was associated with an adult. Three of these individuals under 5 years and two were individuals between 10 to 15 years.

Table 8.3: Frequency and severity of porotic hyperostosis across the entire study sample. 'Slight' = indistinct porosity, 'Moderate' = true porosity, and 'Severe' = coalescing pores.

			Site			Total
			Blue Creek	Nojol Nah	Xnoha	
Porotic Hyperostosis	Overall Porosity	Count	6	3	1	10
		Percent	6.3	3.5	2.9	
	Slight	Count	5	1	0	6
		Percent	83.3	33.3	0.0	60.0
	Moderate	Count	0	2	1	3
		Percent	0.0	66.7	100.0	30.0
	Severe	Count	1	0	0	1
		Percent	16.7	0.0	0.0	10.0
Total Sample Available		Count	96	92	34	222

Of the total Blue Creek sample (n = 96), six individuals showed signs of porotic hyperostosis. Slight porotic hyerostosis was presented in five individuals: four males and one female, and one individual of indeterminate biological sex with severe porotic hyperostosis. All six were adults at the time of death. Within the Nojol Nah skeletal assemblage (n = 86), porotic hyperostosis was present on three (3.5%) individuals. Within the Xnoha sample (n = 34), only one individual exhibited signs of porotic hyperostosis (XO-14-07) (Table 8.3). XO-14-07, an adult male, was between thirty and fifty years old at death and exhibited signs of porotic hyperpostosis on the left parietal.

8.3 Cribra Orbitalia (CO)

Table 8.4: Frequency and severity of cribra orbitalia across the entire study sample. 'Slight' = indistinct porosity, 'Moderate' = true porosity, and 'Severe' = coalescing pores.

			Site			Total
			Blue Creek	Nojol Nah	Xnoha	
Cribra Orbitalia	Overall Porosity	Count	3	4	1	8
		Percent	3.1	4.7	2.9	3.6
	Slight	Count	2	0	1	3
		Percent	66.7	0.0	100.0	1.4
	Moderate	Count	0	3	0	3
		Percent	0.0	75.0	0.0	1.4
	Severe	Count	1	1	0	2
		Percent	33.3	25.0	0.0	0.9
Total Sample Available		Count	96	92	34	222

Like porotic hyperostosis, cribra orbitalia is commonly observed throughout the Maya region (Scherer *et al.*, 2007; Storey 1998; Wright and Chew 1998; Wright and White 1996). Of the 222 individuals only 8 presented with signs of cribra orbitalia (Table 8.4). There were three cases of slight cribra orbitalia present in the sample. Moderate cribra orbitalia was found in three cases, two of which were observed on individuals aged 10 to 15 years old, and one older adult. There were two cases of severe cribra orbitalia (BC-AW-5, and NN-TM-23) both of which were under 5 years old at death. No slight cases of porotic hyperostosis or cribra orbitalia were recorded on immature remains. All of the slight cases were observed on adults which, given the nature of both porotic hyperostosis and cribra orbitalia as discussed in Chapter 3, it is probable that these cases are indicative of healed lesions.

At Blue Creek there were two individuals which presented with slight cribra orbitalia. Only one individual (BC-AW-5), exhibited both porotic hyperostosis and cribra orbitalia; both conditions were severe with coalescing pores (Appendix A). At Nojol Nah, cribra orbitalia was present on four individuals (4.7%) (Tables 8.3 and 8.4). Two individuals (NN-NOS-38 and NN-TM-6) had both porotic hyperostosis and cribra orbitalia. Both of these individuals were buried in or near the Nojol Nah settlement zone within sub-elite contexts (Appendix A). NN-TM-6 had severe cribra orbitalia inside both eye orbits extending along the supraorbital margins (refer to Figure 5.3) and slight porotic hyperostosis was visible along the frontal bones. NN-TM-6 also showed evidence of mastoiditis located on the external auditory meatus of the left temporal bone (section 8.4.2). There were three Nojol Nah individuals who had moderate cribra orbitalia (NN-49, NN-NOS-38, and NN-TM-23). NN-49, a middle adult female not only had presence of cribra orbitalia in the right eye orbit, she also had extensive dental pathologies: large abscesses on the mandible, numerous caries, periodontal disease (as evidenced by pronounced alveolar reabsorption) and linear enamel hypoplasia was present on several teeth (I^1, left and right I^2, and both C^1). NN-49 exhibited both cranial and dental modification. NN-TM-23, a three-year-old individual of indeterminate sex, had severe cribra orbitalia with active lesions in both orbits. Within the Xnoha sample only 1 individual exhibited signs of cribra orbitalia (XO-2a). XO-2a was a young adult of indeterminate biological sex and cribra orbitalia was present in the right eye orbit.

8.4 Skeletal Trauma and Fractures

A small proportion of the population showed evidence of healed fractures (8.1%; Table 8.5). All fractures were observed on adult remains; none were found on immature remains. Of the 222 total skeletal population, 167 individuals could be evaluated for the presence of fractures: 51 came from Blue Creek, 87 from Nojol Nah, and 29 from Xnoha (Table 8.5). There was no significant difference in prevalence of fractures among sites (chi-square 1.987, $p = 0.370$). In the Blue

Creek sample, 11.8% of the skeletal elements showed evidence of fractures, 8.0% at Nojol Nah (Figure 8.1) and 17.2% at Xnoha (Table 8.5).

Table 8.5: All fractures across all three study sites.

			Site			Total
			Blue Creek	Nojol Nah	Xnoha	
Fractures	None Observed	Count	45	80	24	149
		Percent	46.9	87.0	70.6	67.1
	Healed Fracture	Count	6	7	5	18
		Percent	11.8	8.1	17.2	8.1
Total Sample Available		Count	51	87	29	167

Figure 8.1: Well-healed fracture of the distal ulna, NN-50; photo by author.

At Xnoha, of the five individuals with healed fractures, four were excavated within the same structure, Structure 79 in Plaza 78. This cluster of burials is of interest for a number of reasons. Within Structure 79, seven male individuals were exhumed, and all save one (who was about 17-21 years old at death) were older adults around the age of 45-50 years when they died. This group also comprises three of the five individuals exhibiting cultural bodily modifications at Xnoha. Two of these individuals (XO-14-03 and XO14-13) have a healed fracture on a medial phalanx of the hand. Further information on the burials in Structure 79 can be found in Chapter 10 as well as in Appendix A.

Table 8.6: Fractures across all three study sites in relation to biological sex.

			Biological Sex		Total
			Male	Female	
Fractures	None Observed	Count	54	33	87
		Percent	84.4	76.7	81.3
	Healed Fracture	Count	8	6	14
		Percent	12.5	14.0	13.1
Total Sample Available		Count	64	43	101

There was no significant difference in the presence of fractures between males and females (male 12.5%; female 14.0%; F = 0.725, p = 0.772) (Table 8.6). The analysis was not run at the level of individual site, because there were too few data at that level to produce valid statistics. Frequency of skeletal trauma was examined through time for the complete dataset (Table 8.7). However, aside from a slight increase after the Preclassic, across time, fracture rates were continuous and continuity was maintained across the categories.

Since fractures can be related to other health issues such as osteoporosis, statistical tests were run against some of the health indicators seen amongst the three populations. Healed fractures were recorded on seven out of the thirty individuals with DJD (23.3%). However, analysis indicated that there was no significant association between fractures and degenerative joint disease (F = 1.684). When fractures were compared with instances of porotic hyperostosis, again results proved not significant (F = 1.00; p = 1.00). The results were similar when comparing fracture frequencies with cases of cribra orbitalia (F = 0.250; p = 1.00). Thus fracture rates did not have any demonstrable association with the other health indicators observed.

Table 8.7: Fractures through time for the complete dataset.

			Fractures		
			None Observed	Healed Fracture	**Total**
Time Period	Preclassic	Count	18	1	19
		Percent	94.7	5.3	
	Early Classic	Count	68	6	74
		Percent	91.9	8.1	
	Late Classic	Count	37	8	45
		Percent	82.2	17.8	
	Terminal Classic	Count	10	0	10
		Percent	100.0	0.0	
	Classic	Count	16	3	19
		Percent	84.2	15.8	
Total		Count	149	18	167
		Percent	89.2	10.8	

Since fractures can be related to other health issues such as osteoporosis, statistical tests were run against some of the health indicators seen amongst the three populations. Healed fractures were recorded on seven out of the thirty individuals with DJD (23.3%). However, analysis indicated that there was no significant association between fractures and degenerative joint disease ($F = 1.684$). When fractures were compared with instances of porotic hyperostosis again results proved not significant ($F = 1.00$; $p = 1.00$). The results were similar when comparing fracture frequencies with cases of cribra orbitalia ($F = 0.250$; $p = 1.00$). Thus fracture rates did not have any demonstrable association with the other health indicators observed.

8.5 Mastoiditis

Mastoiditis, infection or inflammation of the mastoid process, is rarely diagnosed within the archaeological record (Flohr and Schultz 2009). Mastoiditis results from upper respiratory tract infection that spreads via the middle ear to the air cells within the mastoid process. It is more common in children but may persist into adulthood (Flohr and Schultz: 2009: 271). The presence of mastoiditis can be recognised by the presence of small pinprick-like holes, most commonly on the squama and zygomatic process of the temporal bone (Figure 8.2).

Figure 8.2: Mastoiditis of the left temporal of NN-TM-6; photo courtesy of the Maya Research Program.

There were two cases of mastoiditis observed in the northern Three Rivers Region study, burials NN-TM-6 and NN-NOS-38. NN-TM-6 was an older adult female buried in a flexed position within a crypt within Structure 6 at Tulix Mul, and there were no grave goods found in association. In addition to mastoiditis, this individual had severe cribra orbitalia in the eye orbits, plus slight linear enamel hypoplasia on the mandibular left canine, advanced calculus on several molars. The cranium of NN-TM-6 was modified. NN-NOS-38 was a middle adult male, with dental modification, apart from caries in the third molars, no other indicators of poor health were observed in this skeleton. NN-NOS-38 will be discussed in some detail in Chapter 10.

8.6 Osteomyelitis and Periosteal Reaction

Osteomyelitis is one of the most commonly diagnosed infections found on bone (Rogers and Waldron 1989), and pyogenic osteomyelitis results in cloacae in the bone through which pus is drained. Long bones are the most often affected skeletal elements, particularly at the proximal and distal ends where the highest growth rate occurs, and where infection begins (Rogers and Waldron 1989).

While periosteal reaction was observed in only one case, osteomyelitis was observed in three individuals, in all cases on the shafts of the long bones: the femur, tibia and humerus (Figure 8.3). All cases were pyogenic. Two individuals showing evidence of osteomyelitis were from Nojol Nah (NN-4 and NN-24) and one individual from Blue Creek (BC-AW-12). Today, osteomyelitis is most often seen in children but in ancient osteological contexts, a higher prevalence among adults is the norm. The condition is generally non-fatal but without proper care, infection can be of prolonged duration (Rogers and Waldron 1989). In this particular skeletal assemblage, osteomyelitis was present on the long bones of adults, with the sole exception being the abscesses of NN-49 presented on the mandible.

Figure 8.3: Lesion on the distal humerus of NN-24; the rounded edges of the cloaca can be seen superior to olecranon fossa; photo by author.

8.7 Nonmetric Traits

Sacralisation or lumbarisation of the fifth lumbar vertebra and first sacral vertebra, respectively, are congenital non-metric traits, and can be expressed either unilaterally or bilaterally. While the lumbosacral area supports and distributes body weight and protects the spinal cord, it is unlikely that sacralisation or lumbarisation of vertebrae would be apparent to the person afflicted with this condition, except possibly some slight lower back pain (Jangde *et al.,* 2015: 4061). Within the skeletal population of the Three Rivers Region, there were two cases of sacralisation (refer to Appendix A).

Sternal foramina, or sternal apertures, affect roughly 10% of a given population (Waldron 2009: 22). Of the northern Three Rivers Region, there were only two cases of sternal foramina found within the total skeletal assemblage (n = 18; 11.1%), NN-21A and one of the BC-J14 series (either BC-J14B, BC-J14C, BC-

J14D, or BC-J14E from Kin Tan; for further information, see Appendix B). Even though only 18 sterni were present within the assemblage, the percentage fits with Waldron's (2009) statement of the percentage of population normally affected by sternal foramina. Finally, there were two cases of spina bifida occulta, both from Nojol Nah, Burials NN-1, and NN-9 (refer to Appendix A).

8.8 Burials of Special Interest

There are two individuals within the total skeletal population who exhibit a number of pathologies that are unique; these two cases will be presented within this section. The first (NN-15b) was excavated at Nojol Nah while the other (XO-14-05) was excavated at Xnoha.

8.8.1 Nojol Nah Burial 15b

Figure 8.4: Burial NN-15b; photo courtesy of the Maya Research Program.

Burial NN-15b was interred in a subfloor burial in Structure 4C6 at Nojol Nah (Figure 8.4) Two individuals were buried at this location: NN-15a, an immature aged between two and four years old at death and NN-15b, a female aged between twenty and twenty-five years old at death. Aside from cranial modification, what remains of the splanchocranium exhibits signs of congenital deformation, as well as post-mortem breakage. Asymmetries in the facial bones and mandible were observed.

Potential mandibular malformation is present in the slight flaring of the right ascending ramus (Figure 8.5). This is accompanied by severe calculus build-up on the maxillary and mandibular left molars -- particularly on the maxillary -- while the right molars have minimal evidence of occlusal calculus. This calculus build-up is indicative of the left side being favoured because the teeth were not ground together long enough to slow the accumulation of calculus. The left dentition also exhibits much more wear than the dentition on the right. Both of these traits are highly suggestive of the individual not using the left side of the mouth during mastication, and perhaps not using the left side of the mouth at all. On the right side, an un-erupted right maxillary third molar is positioned so that the crown is facing posteriorly, towards the cranium and the back of the mouth (Figure 8.6). The right mandibular first and second molars below it exhibit little to no wear. Bone behind the right mandibular third molar (facing posteriorly) appears to have grown closer to the palate than on the left. This may account for the disruption and alteration of the molar's growth. Alignment of the palatine bones was observed as asymmetrical. NN-15b also showed evidence of maxillary sinusitis that was active at the time of death. This is highly suggestive that NN-15b was not in good health and was experiencing chronic infection of the sinuses at the time of death.

Figure 8.5: Mandible of NN-15B; photo by author.

Figure 8.6: Maxillary right third molar of Burial NN-15b. Note the angle of the molar, the roots angled across/over the roots of the M2, and the crown appears to be shortened; photo by author.

8.8.2 Xnoha Burial 14-05

Burial XO 14-05 was excavated within the floor of Structure 78 at Xnoha. XO-14-05 was found in comingled context with burial XO-14-07. While XO-14-07 was almost entirely articulated, XO-14-05 was much affected by bioturbation and many of the skeletal elements were displaced. These two burials were part of seven burials under the floor of this structure but separated from the other five burials by a subfloor construction wall. The skeletal remains were in excellent condition despite many missing elements. XO-14-05 was a young adult male, between the ages of seventeen and twenty-one years old at death. This individual, though suffering common pathologies such as the early stages of periodontal disease (as exhibited by the small porosities along the alveolar bone), has both styloid processes present, and they are extremely elongated (Figure 8.7). Both styloid processes are broken, but the remaining right portion measures 29.89 mm and the left measures 15.17 mm. These long styloid processes are highly indicative of a rare case of Eagle's Syndrome.

Figure 8.7: Right temporal of XO-14-05, note the styloid process, photo by author.

Eagle's Syndrome is recognised by the elongation of the styloid process measuring 30mm or more (Balcioglu *et al*. 2009: 266). While neither styloid process of XO-14-05 is longer than 30 mm, both were broken at some point during the taphonomic process and the right side at least was likely 30 mm or longer, as in its current fractured condition it measures 29.89 mm. The average length of a styloid process is between 22 and 25 mm (Balcioglu *et al*. 2009: 265). Eagle's Syndrome can have such adverse effects as difficulty swallowing, chronic sore throat, and facial pain (Baig *et al*., 2012; Balcioglu *et al.,* 2009).

8.9 Summary of Results

The skeletal indicators of health observed throughout the northern Three Rivers Region were presented in this chapter. Analyses were run in order to determine differences in health within and between sites, for males and females, through time and also among different indicators of health. Also discussed were two individual case studies presenting unusual and/or multiple pathologies. There were a few instances of health indicators or non-metric traits affecting only one or two individuals; further information at this individual level is given in Appendix A. While the results presented here pertain to the skeletal population of the northern Three Rivers Region, it is crucial to remember the warnings of Wood *et al*., (1992) in that that general inferences as to the health of the population living at that time are not assumed to be directly correlated to the health indicators affecting the skeletal populations.

When the sites themselves were compared, none of the three stood out as being particularly more affected by poor health (as indicated by skeletal indicators) than the other two sites. In Chapter 11, these results will be discussed in greater detail and the results will also be viewed through a larger lens, looking at how health indicators (types and frequencies) the northern Three Rivers Region compare to the greater Maya region.

Along with Chapter 7, this chapter comprises the analyses of the health of the skeletal population undertaken for this thesis and creates a corpus of information for the subsequent chapters. The following chapter, Chapter 9, will present evidence for cultural skeletal modification from the northern Three Rivers Region.

Chapter Nine

Cranial and Dental Modifications to the Skeleton and Dentition

This chapter presents the results of the assessment of the cultural modification observed on the skeletons and dentition from the three study sites and provides biocultural data to the overall study. Cranial modification will be presented first, followed by dental modification. These two sections will be further subdivided by site. Skeletal modifications on an individual level can be informative; however, without a wider sociocultural context much of what can be learned from the modification is lost. As Tiesler (2014: 13) aptly states:

> The human body, with its physical and psychological properties, figures both as a basis and mediator in all cultural interactions and, as such, is also affected by the social life it supports. Thus, its anthropological study, and that of its cultural modifications, does not only inform on the morphological adaptation and plasticity but equally grants glimpses on society itself.

Thus, how cranial modification relates to biological sex, to presence or absence of burial goods, how modifications may correlate with the type of burial, and changes through time are examined here. The second part of the chapter examines presence and absence of instances of dental modification, and the typology of dental modification observed at each site is examined before delving into what the presence or absence of dental modification means in terms of, for example, relatedness to frequencies of dental pathologies, and occurrences across biological sex. The relationship between cranial modification and dental modification is also explored.

9.1 Cranial Modification in the northern Three Rivers Region

The ancient Maya practiced cranial modification prior to, and during, Spanish contact (see Chapter 3). The meaning of this practice in the Maya region is, however, not fully understood. Early styles included the prominent tabular oblique shaping style (Chapter 3.5.1). Throughout the Early to Late Classic periods, the fronto-occipital flattening style was more common (Tiesler 2010). In the northern Three Rivers Region study, fronto-occipital flattening was the only type of cranial modification recorded throughout all occupation periods.

Table 9.1: Cranial modification through time in the northern Three Rivers Region.

			Cranial Modification		Total
			Present	Absent	
Time Period	Preclassic	Count	0	13	13
		Percent	0.0	100.0	
	Early Classic	Count	13	49	62
		Percent	21.0	79.0	
	Late Classic	Count	9	30	39
		Percent	23.1	76.9	
	Terminal Classic	Count	1	7	8
		Percent	12.5	87.5	
	Classic	Count	4	14	18
		Percent	22.2	77.8	
Total		Count	27	113	140
		Percent	19.3	80.7	

Table 9.1 illustrates the occurrence of cranial modification through time across all three study sites. Even though cranial modification was observed from the Early Classic through the Terminal Classic, normal, unaltered crania (80.7%) vastly outnumbered modified crania overall. Of the crania dating to the Early Classic, 21% were modified, while of the Late Classic crania, 23.1% were modified. In the Classic Period, 22% of the crania had modifications.

Prevalence of cranial modification was not evenly distributed among the sites, as can be seen in Table 9.2. Of the Blue Creek skeletal population, 43 crania were sufficiently well preserved to evaluate for evidence of cranial modification. Of these, only 7.0% exhibited any indication of cranial modification. At Nojol Nah, 77 crania could be analysed for the presence of cranial modification. Of these, 29.9% exhibited cranial modification (Table 9.2). The modified crania from Nojol Nah were found in a myriad of contexts, both within the site core as well as the surrounding area (i.e. Tulix Mul and the Nojol Nah settlement zone).

Table 9.2: Frequencies of cranial modification by site.

			Site			Total
			Blue Creek	Nojol Nah	Xnoha	
Cranial Modification	Present	Count	3	23	1	27
		Percent	7.0	29.9	5.0	
	Absent	Count	40	54	19	113
		Percent	93.0	70.1	95.0	
Total		Count	43	77	20	140
		Percent				

Figure 9.1: Fronto-Occipital cranial modification of NN-54 in situ. NN-54 was buried in a subfloor burial within Structure 4C12, in a flexed position, head to the north, and also had dental modification in type B4; photo by author.

The Xnoha skeletons were all excavated very close to the central plaza, and therefore show a strong affinity in terms of socio-economic status, as many were excavated within the same structures. Of the twenty crania used to score for evidence of modification, only one (XO 15-02) displayed evidence of cranial modification, in the form of fronto-occipital flattening. This individual was a young adult male, possibly in his early twenties. He was buried within a bench in Structure 103, a building that dates to the Early Classic (Guderjan and Hanratty pers. comm. 2015) and the burial itself was marked by a sealed cut in the surface of the bench (Moodie 2016).

XO 15-02 was an unusual burial, not only by being the single individual with cranial modification at Xnoha but also all skeletal elements distal to the first lumbar vertebrae were missing, despite the pristine flexed position of the upper part of the skeleton. The condition of the body could be indicative of the burial being disturbed, and the lower limbs removed. The circular cut mark in the surface of the bench could indicate the re-entry point. Burials within floors are often marked with cut marks, although this is more rarely seen in bench burials. Furthermore, while the upper limbs and torso were intact and in anatomical position, the only recovered lumbar vertebra (L1) was found in reversed position to the rest of the spine[11]. This act would have been completed in antiquity, after which the bench was plastered.

Of the complete skeletal population, ninety individuals could be evaluated for both biological sex and cranial modification. Twelve males exhibited signs of cranial modification (nine of which were from Nojol Nah) and thirteen females exhibited signs of cranial modification. When considering if there were any differences in frequency of cranial modification between males and females, no significant differences were found (male n = 12 (48.0%), female n = 13 (52.0%), Fisher's Exact = 0.0465, p = 0.829)

9.2 Cranial Modification, Porotic Hyperostosis, and Cribra Orbitalia

The focus of this research is to examine rates of health across the region and between the sexes and statuses. Since cranial modification is tied to cultural factors, and porotic hyperostosis and cribra orbitalia are symptoms relating to chronic ill health, it seemed prudent to investigate the correlation between cranial modification and porotic hyperostosis and cribra orbitalia. However, there were

[11] For a similar example found at Lamanai, see Pendergast 1981: 123-143.

no significant differences in the presence of cranial modification and rates of either porotic hyperostosis (p = 0.600) or cribra orbitalia (p = 1.000). This suggests that there is no association between porotic hyperostosis or cribra orbitalia and cultural modification of crania.

9.3 Dental Modification in the northern Three Rivers Region

Table 9.3 and Figure 9.2 illustrate the frequencies of dental modification per tooth in the northern Three Rivers Region. Of the total 1083 adult teeth recorded in the study, 483 could be evaluated for presence or absence of dental modification. This sample of less than half of the total reflects the fact that while the custom of culturally modifying both the maxillary and mandibular incisors and canines was practiced, premolars and molars were not culturally modified and so were excluded from the overall frequency tests. Of the 483, 115 were modified in some manner, either with inlays or by filing.

Table 9.3: Dental modification per tooth in the northern Three Rivers Region following the Molina system. Refer to Chapter 3.6.2 and Figure 3.4 for descriptions of dental modification styles.

Molina Dental Modification Type	Frequency	Percent
B4	49	42.6
A2	25	21.7
E1	11	9.6
C3	8	7.0
B2	6	5.2
A4	6	5.2
B5	4	3.5
C5	2	1.7
F2	2	1.7
A1	1	0.9
C4	1	0.9
Total modification	115	23.8
No modification	368	76.2
Total Teeth	483	

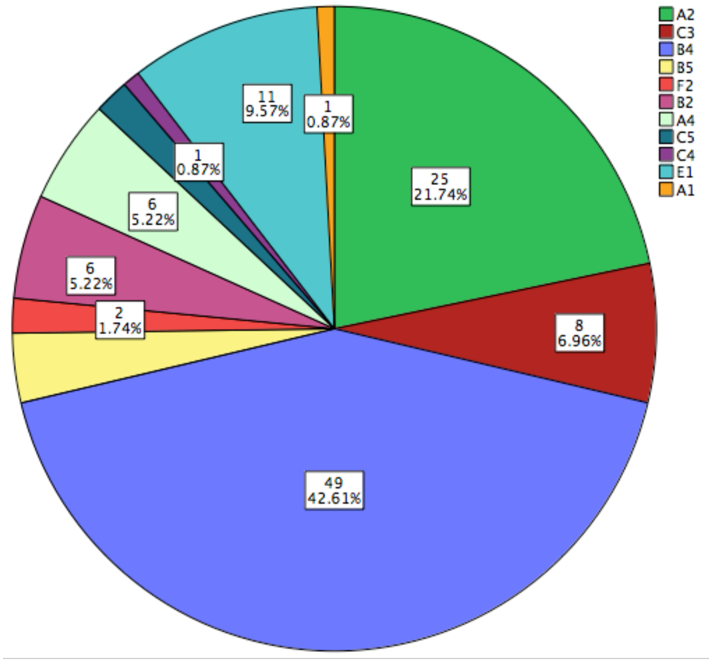

Figure 9.2: Dental modification per tooth in the northern Three Rivers Region following the Molina system. Refer to Chapter 3.6.2 and Figure 3.4 for descriptions of dental modification styles.

There were eleven distinct typologies of dental modification found in the northern Three Rivers Region study following the Molina system of classification. Of these eleven types, the most commonly practiced was the Molina type B4. This falls in line with the larger region of northern Belize as a whole, where the Molina type B4 is thought to be the most common type of dental modification present throughout the Classic period (Williams and White 2006: 148). Following this, type A2 was the second most popular style, with a total of 25 instances in the northern Three Rivers Region skeletal population.

Table 9.4: Presence of dental modification through time for the complete dataset.

			Dental Modification		Total
			Present	Absent	
Time Period	Preclassic	Count	1	0	1
		Percent	100	0.0	1.7
	Early Classic	Count	15	17	32
		Percent	46.9	53.1	55.2
	Late Classic	Count	15	3	18
		Percent	83.3	13.0	31.0
	Terminal Classic	Count	1	3	4
		Percent	25.0	75.0	6.9
	Classic	Count	3	0	3
		Percent	100.0	0.0	5.2
Total		Count	35	23	58
		Percent	60.3	39.7	

Table 9.4 shows the presence and absence of modified teeth (incisors and canines) per individual, for all three study sites through time. There was a total of 58 individuals who could be evaluated for the presence or absence of modified dentition. A majority of these 58 individuals (60.3%), showed some form of dental modification. Whereas in the Late Classic, 83.3% of the skeletal population had dental modification, in the Terminal Classic period only 1 individual (25%) practiced dental modification.

Table 9.5: Dental modification types through time at all three sites.

			Time Period			Total
			Early Classic	Late Classic	Classic	
Modification	A2	Count	7	18	0	25
		Percent	28.0	72.0	0.0	
	C3	Count	1	5	2	8
		Percent	12.5	62.5	25.0	
	B4	Count	30	16	3	49
		Percent	61.2	32.7	6.1	
	B5	Count	2	2	0	4
		Percent	50.0	50.0	0.0	
	F2	Count	0	2	0	2
		Percent	0.0	100.0	0.0	
	B2	Count	2	3	1	6
		Percent	33.3	50.0	16.7	
	A4	Count	0	4	2	6
		Percent	0.0	66.7	33.3	
	C5	Count	2	0	0	2
		Percent	100.0	0.0	0.0	
	C4	Count	1	0	0	1
		Percent	100.0	0.0	0.0	
	E1	Count	0	6	5	11
		Percent	0.0	54.5	45.5	
	A1	Count	0	1	0	1
		Percent	0.0	100.0	0.0	
Total		Count	45	57	13	115
		Percent	39.1	49.6	11.3	

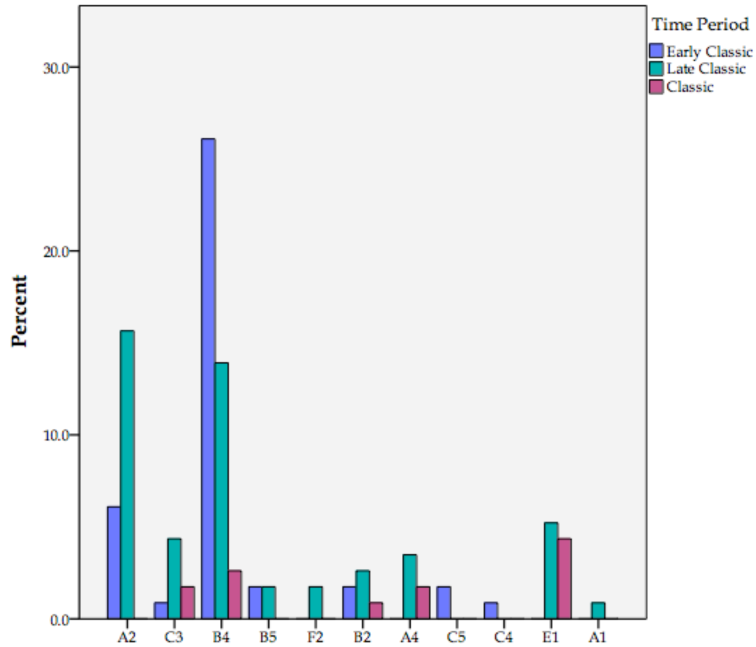

Figure 9.3: Dental modification types through time for the complete dataset.

Presented in Table 9.5 and Figure 9.3 are the prevalence of different forms of dental modifications through time within the complete dataset. Trends in dental modification vary through time, with different styles emerging and fading at various rates (Williams and White 2006). As stated, by far the most common form of dental modification was type B4 on the Molina system (Table 9.5 and Figure 9.3), and this is also true of the nearby Lamanai skeletal population. In fact, this is the case throughout the Classic period, with a total of 49 cases within the dental series. Type A2 was also present throughout the Classic period and the second most frequent type seen amongst the three sites. This popularity in the A2 type differs significantly from the Lamanai skeletal population, which only had one instance of an A2 dental modification (Williams and White 2006: 143). Instead, the second most frequently type observed in the skeletal population at Lamanai was C4, which only appeared in one case in the northern Three Rivers Region series. While B4 was prevalent throughout the northern Three Rivers Region series, there were some typologies that appeared infrequently, such as type C4, which only was present within the Early Classic period, or type A1, which seems to have emerged in the northern Three Rivers Region only in the Late Classic (Figure 9.3).

9.3.1 Dental Modification and Biological Sex

Among the northern Three Rivers Region there was only slight variation in dental modification in regards to biological sex (Tables 9.6 and 9.7). Of a total of 27 males and 24 females with available dentition to observed presence and absence of modification, just over half of each (males = 63.0%; females 66.7%) exhibited some form of dental modification (Table 9.6). Concerning typology of dental styling, A1, B5, C3, and E1 were only observed on males, whereas C4, C5 and F2 were observed solely on females (Table 9.7). However, overall both males and females had very high percentages of A4 and B2. Again, this is expected as both are some of the most frequently observed dental modification types found in populations in northern Belize (Williams and White 2006).

Table 9.6: Presence and absence of dental modification between the sexes.

<table>
<tr><th colspan="3" rowspan="2"></th><th colspan="2">Dental Modification</th><th rowspan="2">Total</th></tr>
<tr><th>Present</th><th>Absent</th></tr>
<tr><td rowspan="4">Biological Sex</td><td rowspan="2">Male</td><td>Count</td><td>17</td><td>10</td><td>27</td></tr>
<tr><td>Percent</td><td>63.0</td><td>37.0</td><td>100.0</td></tr>
<tr><td rowspan="2">Female</td><td>Count</td><td>16</td><td>8</td><td>24</td></tr>
<tr><td>Percent</td><td>66.7</td><td>33.3</td><td>100.0</td></tr>
<tr><td rowspan="2">Total</td><td colspan="2">Count</td><td>33</td><td>18</td><td>51</td></tr>
<tr><td colspan="2">Percent</td><td>64.7</td><td>35.3</td><td>100.0</td></tr>
</table>

Table 9.7: Dental modification by type among the sexes.

			Sex		Total
			Male	Female	
Modification	A2	Count	15	10	25
		Percent	24.2	22.7	23.6
	C3	Count	6	0	6
		Percent	9.7	0.0	5.7
	B4	Count	22	24	46
		Percent	35.5	54.5	43.4
	B5	Count	4	0	4
		Percent	6.5	0.0	3.8
	F2	Count	0	2	2
		Percent	0.0	4.5	1.9
	B2	Count	5	1	6
		Percent	8.1	2.3	5.7
	A4	Count	1	4	5
		Percent	1.6	9.1	4.7
	C5	Count	0	2	2
		Percent	0.0	4.5	1.9
	C4	Count	0	1	1
		Percent	0.0	2.3	0.9
	E1	Count	8	0	8
		Percent	12.9	0.0	7.5
	A1	Count	1	0	1
		Percent	1.6	0.0	0.9
	Total	Count	62	44	106

9.3.2 Dental Modification at Blue Creek

Dental modification of one tooth or several teeth was noted in 9 (9.4%) of the 96 individuals at Blue Creek. Of these nine cases, eight different types of dental modification were identified (Table 9.8; Figure 9.4).

Table 9.8: Dental modification type, per individual dental arcade, Blue Creek.

Modification Type	Frequency	Percent
B4	4	4.2
C5	1	1.0
E1	1	1.0
A4	1	1.0
A2	1	1.0
Total	8	8.3
N/A	88	91.7
Total Teeth	96	100.0

Of these eight types, B4 was the most frequent style seen in the dataset with a total of four instances (or 50.0%); the other types seen appeared at an individual level and were as follows: A2, A4, C5, and E1. Type B4 is the prevalent type of dental modification in the Maya lowlands, particularly with dentitions of biologically female skeletons during the Classic period (Williams and White 2006).

9.3.3 Dental Modification at Nojol Nah

Dental modification at Nojol Nah was a widely practiced cultural tradition. A greater percentage of the skeletal population was found to have culturally modified dentition than not, with 58.49% of the population displaying at least one type of dental modification (Figure 9.4). Dental modification was more widely practiced at Nojol Nah when compared to cranial modification. However, it is also important to consider that this could be due to preservation issues and therefore an overall lack of cranial fragments when equated with dental remains.

Figure 9.4: Dentition of Burial NN-NOS-38; photo by author

Various Molina types of modification were present, often conjunction pairs, or in one case, a set of 3 separate types (Burial NN-7). Even though no single Molina type of modification stands out in frequency, some trends in style were noted, in particular, the relative popularity of Type B4 (Table 9.9).

Table 9.9: Dental modification type per individual dental arcade, Nojol Nah.

Modification Type	Frequency	Percent
A2	2	2.2
B5	1	1.1
B4	15	17.4
B2	2	2.2
F3	1	1.1
Three types	1	1.1
Two types	7	7.6
None observed	25	27.2
Total	57	62.0
N/A	35	38.0
Total Teeth	92	100.0

There does not seem to be an association between cranial and dental modification at Nojol Nah (Figure 9.5). Thus, whether an individual practiced cranial modification did not seem to have an effect on whether that individual also practiced dental modification (Fishers Exact chi-square = 1.8042, p = 0.179). Indeed, the instances of dental modification are greater when there is no cranial modification present. It has been hypothesised that the sociocultural reasons for cranial modification may be completely distinct from those of dental modification (Tiesler 1999). The results here support this assertion, suggesting that these two cultural practices were not consistently utilised by the same individuals.

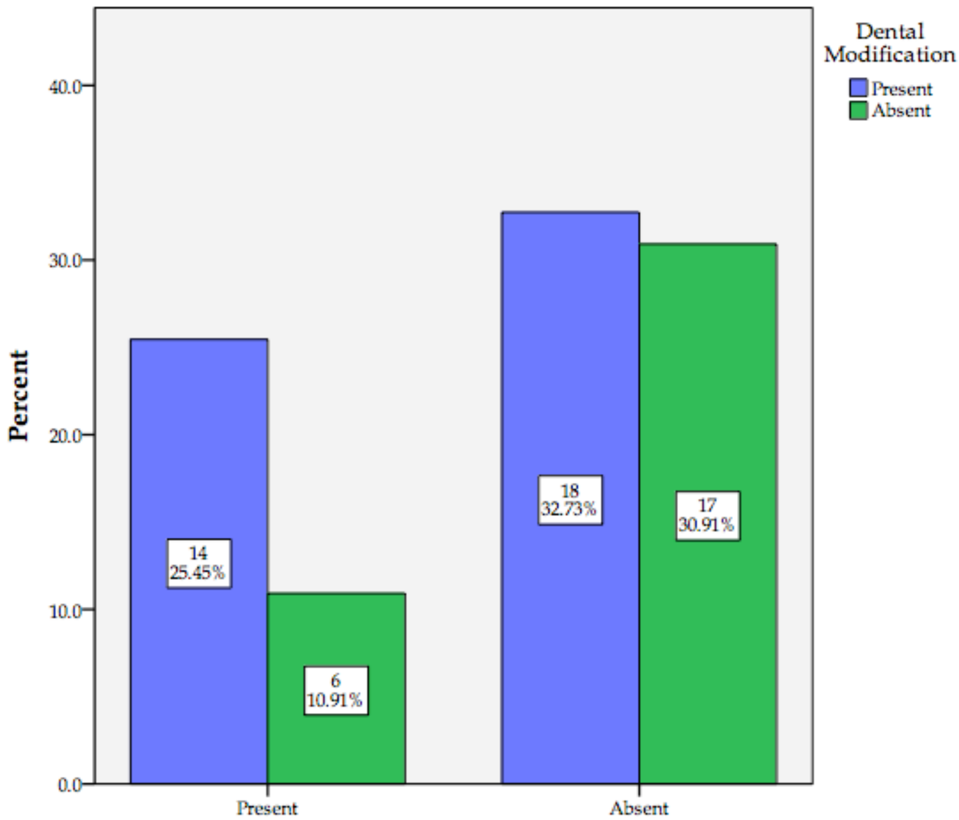

Figure 9.5: Percentage of cranial modification in relation to dental modification at Nojol Nah.

8.3.4 Dental Modification at Xnoha

There were 4 cases (22.2%) out of the 34 observable crania at Xnoha that exhibited some type of dental modification (XO-14-03, XO-14-08, and XO-14-13). However, it is worth noting that a number of burials at Xnoha are those of sub-adults and therefore they would not yet be old enough to partake in the practice of dental modification (refer to section 9.3.4 of this chapter). Of the four cases that do exhibit dental modification, three were found within the same context, in pit burials within the construction fill of the floor of Structure 79 at Xnoha, a Late Classic building just to the east of the Xnoha Central Plaza. All three burials in this context were male and all were middle to older adults. Of the three, two suffered from broken phalanges in the hand. These three cases of dental modification were not the only individuals found in subfloor burials within Structure 79 at Xnoha; three others were also found in association (XO-14-05, XO-14-07, and XO-14-09). The fourth was a middle-aged adult male, buried within Structure 16A.

Figure 9.6: Dental modification of XO 14-13; photo by author

The dental modification present on the three sets of dentition consists of a number of separate typologies from the Molina System. The first, XO-14-03, had dental modification in the form of type C3 on all four upper central incisors. XO-14-07 had dental modification on the maxillary right central incisor, modified in Type B3, the left lateral incisor is in Type B7, and the left canine is in Type A1. Finally, XO-14-13 has dental modification in the form of A2 and B2 on the upper central and lateral incisors and right canine respectively (Figure 9.6).

9.3.5 Dental Modification and Caries

There have been recorded instances of dental modification in Mesoamerica perforating the pulp chamber of the tooth, and therefore leaving the tooth venerable to caries and abscesses (Verianai *et al*., 2011: 1001). Because of this, statistical analysis in the form of Fisher's Exact test were run for all of the maxillary and mandibular central and lateral incisors and canines, for a complete dataset of 480 dentitions. This was to determine whether there were any significant differences in rates of carious lesions affecting culturally modified dentition. There was no significant difference (Fisher's Exact chi-square = .800, p=0.198). Dental modification in the northern Three Rivers Region did not seem to have an effect on the formation of dental caries (Table 9.10). This result is strengthened by the fact that there were no cases in the assemblage in which the pulp cavity of the tooth was observed as exposed.

Table 9.10: Cross-tabulation of frequencies of caries in relation to dental modification.

			Modification		Total
			None Observed	Modification Present	
Caries	None Observed	Count	343	105	448
		Percent	94.2	90.5	93.3
	Caries Present	Count	21	11	32
		Percent	5.8	9.5	6.7
	Total	Count	364	116	480

9.3.6 Dental Modification and Immature Dentition

Dental modification was observed in only one individual of the immature population. The only subadult to exhibit any form of dental modification was BC-AW-4, from Aak Witz, of the Blue Creek population. Both left and right upper canines were modified in type C5 (Figure 9.7). As mentioned in Chapter 6, both canines also have the vertical lines characteristic of linear enamel hypoplasia.

Figure 9.7: Canines of BC-AW-4, in type C5 modification; photo by author.

The individual was between the ages of 12 and 15 years old at age at death, likely in the older range of that scale as individuals younger than 15 rarely exhibit dental modification. The Maya did not practice dental modification until all incisors and canines were in occlusion, and therefore not before 15 years of age (Tiesler Blos 2001; Williams and White 2006: 139).

9.4 Summary of Results

Cranial and dental modification in Mesoamerica date back to the Olmec, and the Maya practiced these bodily modifications since the Formative/Preclassic period. This chapter focused on the cultural modifications to the skeletons within the assemblage of the northern Three Rivers Region. Cranial and dental modifications were discussed at several levels: the entire dataset, individual sites, between the sexes and through time. While the exact aetiologies of cranial and dental modification are still debated, practices of modification are widely observed in the skeletal populations of the Maya region. Fronto-occipital flattening was the sole style of cranial modification observed among the three study sites and while there were a variety of styles of dental modification recorded among the three sites, type B4 was the most frequent. The intention of the chapter was to examine both the cultural modifications and their correlation with various pathologies, as well as to record the modifications within the skeletal series of the northern Three Rivers Region.

Chapter Ten

Burial Contexts and Artefact Assemblages in the Northern Three Rivers Region

This chapter presents results of the analysis of burial forms as well as associated grave goods found within the northern Three Rivers Region. First, the separate burial types will be discussed, followed by the associated burial artefacts. Burial assemblage becomes important when discussing health difference between the sexes, or across socioeconomic class as burials help to contextualize the data gathered. This chapter focuses on the archaeology rather than the osteology of these burials and comprises the last the chapter on the results of the study prior to the discussion and conclusions.

9.1 Burial Practices of the northern Three Rivers Region

In Chapter 2, recurrent Maya burial types were briefly examined. The results of the burial practices and grave goods analysis of the northern Three Rivers Region are given. Burials act as a way to create connections between people and the landscape, and burial type and placement play large roles in that concept (see section 2.4.3).

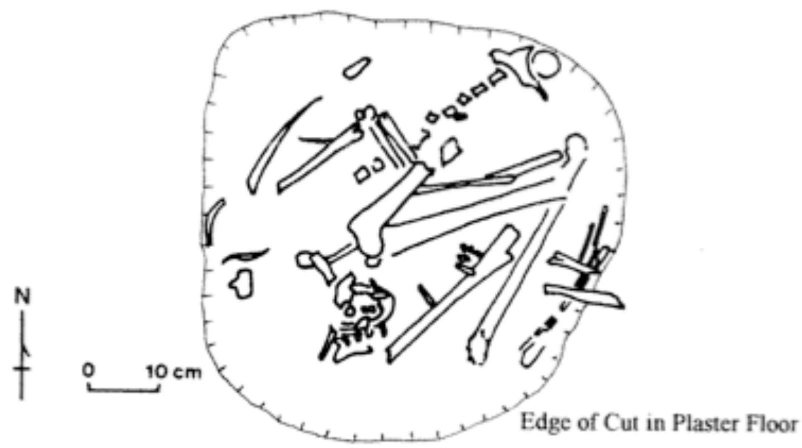

Figure 10.1: Plan view map of Burial BC-5, of Blue Creek, a subfloor burial; Structure 9, Room B; BC-5 was a primary interment, buried in a flexed position; image courtesy of the Maya Research Program.

Of the total dataset (N = 222) there were 162 (73.9%), for which burial type could be identified and recorded. These comprised both primary and secondary interments. More than a quarter (26.1%) of interments could not be designated a grave type, due to inadequate recording of the burial by the excavators or due to destructive bulldozing or looting prior to excavations. The most common type of burial in the northern Three Rivers Region was the Subfloor burial. Subfloor burials comprised over 70% of the total interment types (Figure 10.1). Crypt and Bench burials were encountered at approximately the same low frequency, while Tombs were even rarer (Figure 10.2).

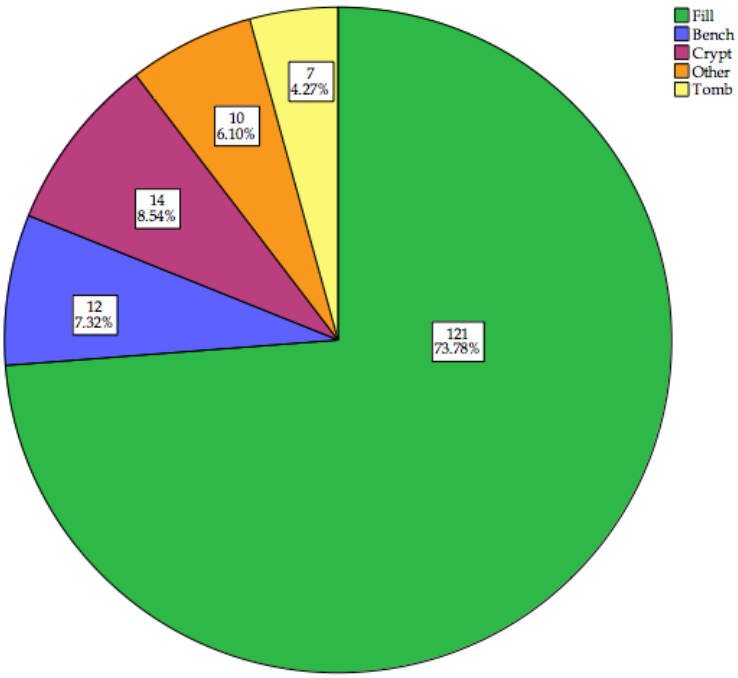

Figure 10.2: Burial types of the northern Three Rivers Region. Note, 'Fill,' refers to subfloor burials, while 'Other' refers to nonconforming burials, which will be discussed in section 10.3.

As discussed in Chapter 2 (section 2.5.4), subfloor burials are the most common type of burial seen in Mesoamerica (McAnany *et al*., 1999; Wright 2006). It is unsurprising then, that this is also true of the northern Three Rivers Region. Of the total study sample, subfloor burials comprised nearly 75% of the total dataset (73.78%, n = 121). When the sites are divided, subfloor burials remain the most common burial type by far, representing 70% of the burial types at Blue Creek (n = 35), 76.5% at Nojol Nah (n = 62), and 72.7% at Xnoha (n = 24).

Crypt burials, the second most common burial type, comprise 8.5% of the assemblage. Crypt burials were found at all three sites. At Nojol Nah eleven crypt burials were recovered, while at Xnoha two crypt burials were found and at Blue Creek only a single crypt burial (Table 10.1). At Blue Creek the crypt burial (BC-2) was interred within Structure 9 at the Blue Creek site core, while at Nojol Nah the crypt burials were found in the subfloor of numerous structures. The two crypt burials at Xnoha (XO-13-01 and XO-14-14) were both found underneath the floor of Plaza 78 (refer to Figure 2.6). Both have been dated to the late Preclassic based on ceramic analysis of the ceramic sherds found within the floor fill surrounding the burials. XO-13-01 was an older adult of indeterminate biological sex. A single large jade bead was found in association with this crypt. XO-14-14 was buried in a flexed position with the head facing north. The individual was an adult of indeterminate biological sex. The burial included a number of grave goods: a jade cylinder bead, and two beads carved into designs which, when combined, create the ‘kin’ sign meaning ‘sun’ or ‘day’ (Figure 10.3) and is typically associated with divine kingship, (Montgomery 2002: 151).

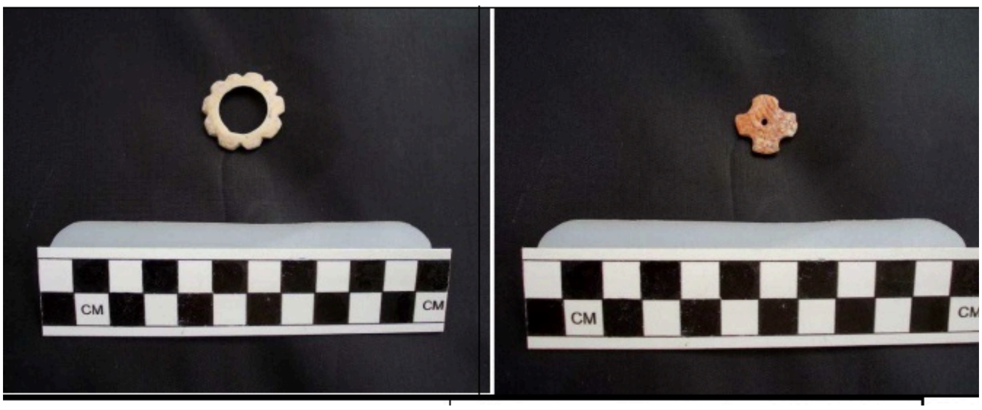

Figure 10.3: Conch shell (left) and red coral (right) beads found in association with burial XO-14-14, images courtesy of A. Parmington, 2014.

Table 10.1: Burial types across all three study sites.

Burial Type		Site			Total
		Blue Creek	Nojol Nah	Xnoha	
Fill	Count	35	62	24	121
	Percent within Site	70.0	76.5	72.7	73.8
	Total Percent	21.3	37.8	14.6	73.8
Bench	Count	0	8	4	12
	Percent within Site	0.0	9.9	12.1	7.3
	Total Percent	0.0	4.9	2.4	7.3
Crypt	Count	1	11	2	14
	Percent within Site	2.0	13.6	6.1	8.5
	Total Percent	0.6	6.7	1.2	8.5
Other	Count	7	0	3	10
	Percent within Site	14.0	0.0	9.1	6.1
	Percent of Total	4.3	0.0	1.8	6.1
Tomb	Count	7	0	0	7
	Percent within Site	14.0	0.0	0.0	4.3
	Percent of Total	4.3	0.0	0.0	4.3
Total	Count	50	81	33	164
	Percent of Total	30.5	49.4	20.1	100.0

Of the twelve Bench burials, eight were located in Nojol Nah, four at Xnoha while none were recorded at Blue Creek (Table 10.1), although this might have to do with the issues stated at the beginning of this section in regards to preservation and records. Only two of the Bench burials had any associated burial artefacts, which will be discussed in section 10.5.

Tombs represented 4.3% of the total burials, and were excavated only at Blue Creek. Even though seeming to suggest tombs were exclusively used at Blue Creek, there is evidence to suggest that this form of burial may have been more widely represented at the northern Three Rivers Region sites. There is one example of a looted tomb at Structure 1 of Nojol Nah (Dickson 2008: 99). No skeletal material remained and so the tomb is not included in this analysis; nevertheless this example suggests that at least one tomb was present at Nojol Nah. At Xnoha, excavations thus far have focused largely on household structures and therefore the monumental architecture where tombs might be more frequent have yet to be fully excavated. It is possible, therefore, that tombs exist at Xnoha, but have yet to be excavated. Tomb 5 at Blue Creek is an unusual case and is discussed in detail later in this chapter (section 10.2.1).

Included in the unknown category, those that were left out of the statistical tests due to insufficient data are three burials from the Nojol Nah Settlement Zone which were found bulldozed. Two of the burials which could not be assigned a burial type are very likely to have been crypt burials (Hammond 2012). Both burials (NN-NOS-38 and NN-NOS-40) were adult males that had undergone dental modification (types A2 and E1). A third burial in the same structure (NN-NOS-41) was interred in what appeared to be a large crypt under the floor of Room 1 and was unaffected by the demolition. This burial was also an adult male, who had both dental modification (type B4) and cranial modification.

10.2 Non-Conforming Burials

There were a small number of burials within the assemblage which deserve to be explored further as they do not fit directly into the categories prescribed for the region and time periods. These are the burials excavated at Blue Creek: Tomb 5; the individuals buried in J-14, a chultun excavated at Kin Tan; the burial caches; and at Xnoha, the burials in Structure 10 by the staircase.

10.2.1 Blue Creek Tomb 5

Technically this interment falls into the tomb category (and has been included in analysis above as an example of a tomb), but there are aspects which make it an unusual case and thus further detail is warranted. This tomb (Figure 10.4), in which three individuals were interred (BC-34, BC-35, BC-36), is situated on a high hill overlooking the confluence of the Rio Bravo and Rio Azul, about 4.25 kilometres northeast of the Blue Creek site core (Guderjan *et al*., 2014). The structure of the tomb itself is what makes this burial atypical in this study sample: rather than the more common vaulted chamber tombs seen throughout Mesoamerica, Tomb 5 was dug directly into the limestone, creating a large chultun-like chamber (Guderjan *et al*., 2014). This chamber measures two meters wide and 1.6 meters high (Guderjan *et al*., 2014.). The tomb itself dates to the Late Preclassic (AD 100-50 to 250AD). Due to this early date, it remains ambiguous as to whether Tomb 5 is related to Blue Creek, or if it pre-dates Plazas A and B of the Blue Creek site core (Guderjan *et al*., 2014). However, by the end of the Preclassic, Blue Creek was already a well-established polity; therefore it is very likely Tomb 5 and the Blue Creek site core are related.

The last interment into Tomb 5 was BC-34 while BC-35 and BC-36 had been interred at an earlier time as can be inferred from BC-35 and BC-36 being secondary to BC-34. The skeletal remains of BC-34 were arranged in an extended supine position lying atop a bed of faunal remains, primarily fish but also birds, reptiles, amphibians and small mammals, totalling an assemblage of about five to ten centimetres deep (Guderjan *et al.,* 2014). Sixty percent of the fish were from a cichlid (*Petenia splendida)*. The remainder were mostly the bones of smaller fish although two species of catfish and two stingray spines were also identified (Guderjan *et al*., 2014). Marine shells and bone fragments of various species of bird, amphibian, reptile and mammal, including the remains of armadillo were also recovered (Guderjan *et al.,* 2014). BC-34, was wearing a jade necklace consisting of twenty-eight beads, and a 12 bead jade bracelet on the right wrist. Other associated artefacts included powered hematite, worked shell, obsidian, jade and copal (Guderjan *et al.,* 2014). BC-34 was a male between 25-35 years old at age-at-death (more likely on the older end of this estimate). The remains were highly fragmentary and only about 35% of the skeleton was recovered. Slight calculus was present on two teeth and slight porotic hyperostosis is visible on the cranial fragments. The individual had healed fractures on both a left metacarpal and right metatarsal. A number of the cranial fragments were coloured with red ochre (for further discussion on this practice, refer to Chapter 11, Section 11.7).

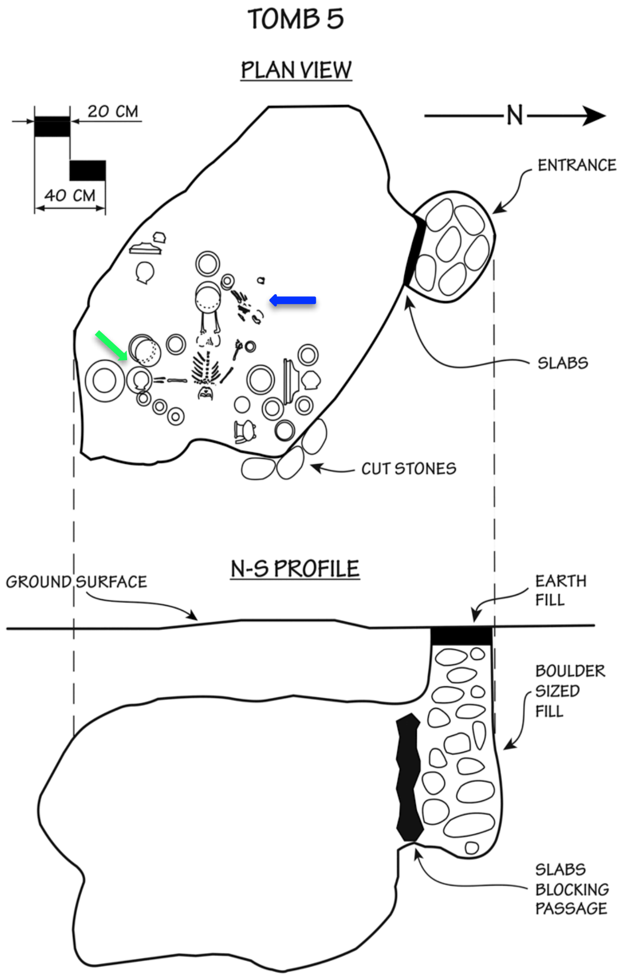

Figure 10.4: Plan view and profile of Blue Creek Tomb 5; image courtesy of T. Guderjan. Arrows added by author. BC-34 represented by primary skeletal remains, blue arrow indicates location of BC-35, and green arrow the ceramic vessels containing BC-36.

Burial BC-35a was placed at the feet of BC-34 in a tightly flexed, possibly bundled position (Guderjan *et al.*, 2014). Surrounding these two burials was an assemblage of twenty-eight large ceramic vessels of which three (BC 5713, BC 5717, and BC 5723; Figure 10.4) held the remains of a third individual (BC-36) (Guderjan *et al*., 2014; Telepak pers. comm. 2014).

BC-35 is estimated to be an adult male between thirty and forty years at age-at-death. Slight osteophytosis was present on the body of the thoracic vertebrae as well as slight cribra orbitalia in both eye orbits. A healed fracture on the right fourth metatarsal was observed. BC-35 was buried with seven jade beads of a similar style to those present with BC-34 (Guderjan *et al*., 2014).

The third individual, BC-36, was interred in three ceramic vessels (Figure 10.4). Vertebrae, ribs, ulnae and a clavicle were recovered from one vessel (BC 5717); a coccyx was found in another one vessel (BC 5713) while a third vessel held phalanges (BC 5723) (Guderjan *et al.,* 2014; Guderjan pers. comm. 2014; Telepak pers. comm. 2014). It is possible that these remains are from two separate individuals based on the apparent age-at-death differences between the vertebrae, which were fully mature, and the partial clavicle, which could have belonged to an immature individual (Guderjan *et al*., 2014). However, the clavicle is one of the final bones in the human body to fully fuse and so it is possible that BC-36 does represent just one individual, an individual who was a young adult at death. The northern Three Rivers Region study was unable to corroborate or refute this hypothesis of a second individual, as the remains of BC-36 are no longer present at the Maya Research Program basecamp.

It has been argued that Tomb 5 at Blue Creek acts as a physical representation of Maya cosmology and the Maya universe (Guderjan *et al*., 2014). Seen in various representations throughout the Maya region of Mesoamerica (Fizsimmons 2009: 47-49; Mead *et al*., 2015), including many caches at Blue Creek (Guderjan 1997: 9), the tomb contents incorporate the ideas of a watery underworld (represented by the fish and marine remains), the earth, (represented by the mammal and other vertebrate remains as well as the jade and obsidian) and the sky (represented by the bird bones and inverted ceramic vessels placed lip to lip, an analogy to the sky in Maya caches) (Guderjan *et al*., 2014). Directionality and placement were important factors for the Maya when burying their dead (see Chapter 2). The primary individual of Tomb 5, BC-34, was placed with feet to the west, which Guderjan and colleagues (Guderjan *et al*., 2014: 12) argue is related to the ‘dying sun as it enters Xibalba’.

10.2.2 Blue Creek Kin Tan Chultun J-14

The remains of five individuals (BC-KT-J14a; BC-KT-J14b; BC-KT-J14c; BC-KT-J14d; BC-KT-J14e) were found found in a *chultun* outside of Structure B at Kin Tan, the elite residential *barrio* adjacent to the Blue Creek site core (Figures 4.2 and 4.6). *Chultuns* had many uses throughout Mesoamerica, including as a means of interment but also for water collection and storage (Coe 2005: 56; Guderjan 2007: 75-76; Hammond *et al*., 1995). This particular *chultun* contained the remains of five males, all of different ages at the time of death (see Appendix A).

10.2.3 Burial Caches

Human remains found in dedicatory cache contexts are found throughout the Maya region and are placed at an entrance stairway or entranceway (Chase and Chase 1998). At times there might be a single phalanx represented in the assemblage, or sometimes an entire immature skeleton. Of the northern Three Rivers Region skeletal assemblage, there are two known examples: BC- Cache 2, and a cache at the Structure 10 staircase at Xnoha. BC- Cache 2 consists of the remains of an immature around 18 ±6 months at death[12] (refer to Chapter 6 Section 6.1.4; Appendix A). The remains were found in a ceramic vessel within Structure 9 at the site core of Blue Creek.

The burials at the staircase on Structure 10 at Xnoha are disarticulated bundled remains comprising three separate individuals (XO-15-01a, XO-15-01b, and XO-15-01c). The remains were found in collapse on the stairway at the front of the structure (Pastrana and Trowbridge 2016). All three of the remains were adult males. The structure itself dates to the Preclassic, while the remains date to the Early Classic period, based on the associated artefacts found interspersed with the skeletal remains in the marl (Hanratty pers. comm. 2015). The reason behind this time discrepancy is not yet fully understood.

10.3 Burial Type, Biological Sex, and Age at Death

The occurrence of both males and females in Subfloor and Bench burials suggests that neither sex was excluded from these types of interment (Table 10.1). However, only males occurred in Tomb burials and in the non-conforming burials, ($p = 0.007$), meaning that there was a significant difference in burial types between males and females. While females have been placed in tombs elsewhere

[12] BC-Cache 1 did not include any human remains.

in the Maya region (Tiesler *et al*., 2004; Pendergast 1981) in the northern Three Rivers Region males are found to be the sole occupiers.

Table 10.2: Frequencies of burial type in relation to biological sex for the complete dataset.

			Biological Sex		**Total**
			Male	Female	
Burial Type	Fill	Count	27	32	59
		Percent	58.7	84.2	70.2
	Bench	Count	2	1	3
		Percent	4.3	2.6	3.6
	Crypt	Count	5	5	10
		Percent	10.9	13.2	11.9
	Non-conforming	Count	7	0	7
		Percent	15.2	0.0	8.3
	Tomb	Count	5	0	5
		Percent	10.9	0.0	6.0
Total		Count	46	38	84

When looking at burial types in relation to age at death (adult versus immature) the most common interment type for any age group was a subfloor burial (Table 10.3). This is to be expected as subfloor burials were the most common type of burial overall (Table 10.1). If examining primary and secondary burials, the adult skeletal population had seven instances of secondary interments whereas not a single immature burial was found in a secondary burial context. There were, however, numerous instances of immature individuals being buried alongside adults (for details refer to Appendix A) which is a trend often seen in the Maya region (McAnany *et al.,* 1999). Of the seven burials that could confidently be recorded as secondary interments, all were found in crypt contexts at Nojol Nah.

Table 10.3: Frequencies of age (adult or immature) in relation to burial type, for the complete dataset.

			Age Categories		Total
			Adult	Immature	
Burial Type	Fill	Count	102	19	121
		Percent	74.5	79.2	75.2
	Bench	Count	9	3	12
		Percent	6.6	12.5	7.5
	Crypt	Count	14	0	14
		Percent	10.2	0.0	8.7
	Other	Count	7	2	9
		Percent	5.1	8.3	5.6
	Tomb	Count	5	0	5
		Percent	3.6	0.0	3.1
Total		Count	137	24	161

10.4 Artefact Assemblages in Burial Contexts in the northern Three Rivers Region

In many modern Maya communities in the Guatemalan highlands, to the west of Belize, shaman (known as *h'men*) perform the burial ceremony and grave goods such as gourd cups, clothing, food and money are interred along with the deceased (Wright 2006: 38). Burial goods can vary by gender; for example the Tzotzil Maya bury spindle whorls in women's graves. Similar practices are seen among the Lacandon of Chiapas, Mexico (Wright 2006: 38). Ancient Maya burial artefacts often have marine associations that relate to images and ideas of the Maya otherworld, and this is especially true during the Classic Period. These associations may relate to the primordial sea, as described in the *Popol Vuh,* which existed prior to the creation of human beings (Wright 2006: 41). Examples of representation of the otherworld not just limited to burial assemblages include epigraphic representations on ceramic vessels, and shells and stingray spines (Wright 2006: 52). Stingray spines were used in bloodletting rituals and therefore, depending on context, could be representative of auto- bloodletting through the tongue or penis (Coe 2005: 83; Wright 2006: 52). Entire artefact assemblages often reflect this theme, as is the case with the previously discussed Tomb 5 at Blue Creek (section 9.3.1; Guderjan *et al*., *in press*).

Ceramics, either whole, or in sherds, and at times with a 'kill-hole' in the centre (Golden *et al.,* 2008: 264; Guderjan 2007: 77), were typical burial goods which were generally placed under or over the skull of the deceased (Guderjan 2007: 77; Welsh 1988: 216) or near the deceased individual (Welsh 1988: 216). The quality and quantity of these items have been interpreted as sensitive indicators of the deceased's economic status (Fitzsimmons *et al.,* 2003: 449; Guderjan 2007: 80; Lucero 1999: 229). However, as will be discussed in further detail in Chapter 10, this interpretation may be flawed.

Of the total dataset, 49 (22.1%) burials provided evidence of grave goods, whereas 70 (31.5) of the burials were devoid of grave goods. There were 103 (46.4%) burials that had to be excluded from the dataset because information about presence or absence of burial goods was not recorded or the records were lost. This is particularly true for the Blue Creek grave goods assemblage. At Blue Creek there was almost an equal number of burials with grave goods as those without (52.2% of the burials contained grave goods); however, the majority of the burials at the site could not be included in the analysis due to the aforementioned lack of information. Out of the 92 burials that comprised the Nojol Nah burial assemblage, 56 (73.7%) had no associated grave goods while 20 (26.3%) were found to have burial goods present (Table 10.4). At Xnoha 50% of the burials contained grave goods (Table 10.4).

Table 10.4: Presence and absence of burial goods in the northern Three Rivers Region

			Artefacts present		
			Present	Absent	**Total**
Site	Blue Creek	Count	12	11	23
		Percent within Site	52.2	47.8	100.0
		Percent of Total	10.1	9.2	19.3
	Nojol Nah	Count	20	56	76
		Percent within Site	26.3	73.7	100.0
		Percent of Total	16.8	47.1	63.9
	Xnoha	Count	17	3	20
		Percent within Site	85.0	15.0	100.0
		Percent of Total	14.3	2.5	16.8
Total All Sites		Count	49	70	119
		Percent within Site	41.2	58.8	100.0
		Percent of Total	41.2	58.8	100.0

The paucity of grave artefacts in the northern Three Rivers Region is remarkable when contrasted with pre-existing ideas on the subject of status and material wealth in the Maya region. Typically, it is considered that the presence and quality of artefacts buried within interments are good indicators of socioeconomic status or power within the community or even across polities (Wright 2006: 43). However, it is pertinent to note that burial goods might not always correspond to social status or wealth (Ucko 1969: 266-267). As Burger (1992: 206) argues on burial practices of the ancient Chavin culture, in present day Peru, the 'inclusion of these objects was ultimately an aspect of the funerary rituals which were intended to convey public messages to the living. Consequently, they do not always mirror the social realities of the past.' Gillespie (2001: 77) warns that artefacts associated with burials might in fact be seen as markers of the mortuary ritual itself, rather than as a social marker of the deceased individual.

While a lack of burial goods might be interpreted as the interred being of low socioeconomic status, this does not appear to fit with any of the Nojol Nah, Blue Creek or Xnoha samples. For example, based on other often inferred indicators of status, such as proximity to the site core (*Kawuik)*, and the means of construction of the structures and burials in which the remains were excavated, it is suggested that the people of Nojol Nah, including Tulix Muul, and the Nojol Nah settlement zone, were of elite and sub-elite status (Brown 2013; Hammond 2015).

Even though grave goods are comparatively rare amongst the assemblages in the northern Three Rivers Region study, it remains important to consider the types of artefacts that were recovered from the burials, and types of burials. The artefacts found across the complete dataset comprised a total of eight types; however of these eight types, three were single occurrences (a mano, a biface, and an incensario; see Figure 10.5). The more frequently encountered grave goods were: ceramics (n = 19), obsidian (n= 11), faunal remains (n= 10), jadeite (n = 9), marine shell (n = 7; Figure 10.6), and matates (n =2). When there was more than one artefact present in a grave, mixed assemblages of different object types were the most frequently recorded.

Figure 10.5: Turkey incensario, measuring 16cm across and 14cm in height (A. Parmington 201: 67), excavated in association with burial XO-14-14; photo courtesy of the Maya Research Program.

The obsidian objects were either in the form of small fragments or blades, whereas the ceramics were quite varied in terms of style and size, from the 'kill-hole' bowls discussed earlier, to *chilar* fluted vessels (Brown 2011). The associated faunal remains were mainly dog remains, for example, a dog's tooth pendant, a dog vertebrae. In fact, all examples of animal bone found in burials were dog, except for the diverse assemblage of faunal bone from Blue Creek Tomb 5.

It is plausible that certain types of grave goods are found more frequently amongst burials of a particular type, creating specific grave assemblages (West 2002). However, there was no significant association between the various burial types and artefact types, nor burial types and presence/absence of artefacts ($F = 7.562$; $p = 0.136$). At Nojol Nah, some subfloor burials contained jade artefacts and some a mixed assemblage of artefacts (jade was found in one Subfloor burial and artefact assemblages were found in three subfloor burials). However, of the eight Bench burials at Nojol Nah only two (NN-35; NN-TM-5) had any associated artefacts, two jade ornaments (NN-35), and fifty-three worked shell ornaments (NN-TM-5) (Figure 10.6). What is also striking about the various artefact assemblages found within these burials is the variability, and the uniqueness of type or types of grave goods placed within the burials, e.g., the burials of XO-14-14 and NN-TM-5. This is suggestive of funerary rituals in the region not being repetitive or unified; however they may have been complex but structured, or up to the individual or the individual families.

Figure 10.6: Worked shell ornaments from burial NN-TM-5; photo courtesy of G. Hammond, 2012.

10.5 Burial Status and Health Indicators

To determine whether there were significant differences in health indicators among various burial contexts, a Chi Square Fishers Exact test was applied. When artefact assemblages were compared to frequencies of dental pathologies, in each case there were no significant correlations observed (dental caries = 0.780; calculus = 0.276, LEH = 0.143). When dental pathologies were compared with burial types, again no significant correlation was found (caries = 0.72; calculus = 0.118; LEH = 0.614). However, assessing burial types is not sufficient as subfloor burials are frequently found in sub-elite contexts. Instead, the areas, *barrios*, in which the burials were excavated were used as a proxy variable, which provided further context on socioeconomic status (refer to Table 4.2). However, as before, there were no significant differences found between rates of caries and calculus and excavation site (caries = 0.267; calculus = 0.358). When assessing LEH rates among the various barrios, a significant difference was found (chi-square fishers exact test = 0.007). At the Nojol Nah site core, there were 56 individual cases of LEH, equalling nearly half of the total cases of LEH (46.7%). Again, it should be noted that preservation could potentially have played a role as the dataset from Nojol Nah is in good to excellent condition. The Chan

Cahal skeletal sample, as mentioned, was the least economically advanced group in the study, and out of the 22 individuals exhumed from Chan Cahal, only a two had dentition present. Correlations were also run for skeletal health indicators. However, there were no significant differences found in any of the assessments (DJD = 0.513; porotic hyperostosis = 0.250; cribra orbitalia = 0.171).

10.6 Summary of Results

This chapter outlined the results of the burial types and artefact assemblages observed in the northern Three Rivers Region. Burial types among the three sites were discussed, both common burial forms as well as burials which do not fit into the typically prescribed categories for the greater Maya region. Burial artefacts were also examined, by presence or absence and by type. In terms of associated burial artefacts, the relatively low number of artefacts was discussed. The northern Three Rivers Region lacked the more elaborate tombs and burial accoutrements found in many Classic sites.

The majority of the study sample was considered to be of elite or sub-elite classes (Barrett 2004; Barrett and Brown 2009; Brown 2011; Brown *et al.*, 2014; Driver 2008; Guderjan 2007; Hammond 2015; Hanratty and Driver 1997; Parmington 2014; 2015). This is due to both the architecture of the buildings in which the individuals were interred as well as the proximity of the burial or tomb to the site core. The predominant burial type across the time periods and geographic area was the subfloor burial. The relationship between wealth, status, sex, and burial elaboration is a complex one, and that complexity is borne out in the evidence presented in this research. The final two chapters of this thesis present a discussion of the key themes and elements examined in the northern Three Rivers Region study, and the conclusions drawn from the analysis.

Chapter Eleven

Discussion

The aim of this research was to examine the health of populations from Blue Creek, Nojol Nah, and Xnoha, to assess if there were any significant differences among the three populations, and if so what those differences might be and the potential underlying reasons. First, a discussion of the results of the health of dental and skeletal remains in the study will be given, followed by a general examination of health throughout the occupational time periods of northern Three Rivers Region. The effect of socioeconomic status will be discussed, as well as the relatedness of health indicators to biological sex. Childhood health in the northern Three Rivers Region is also considered, and how this might differ from that of the adult population. Cultural modifications to the skeleton and the health implications therein are examined, as is a discussion of Maya funerary practices. Finally, a section on health of the Preclassic and Classic Maya is given as a means to place the data on health indicators from the northern Three Rivers Region into a larger context in order to compare the health of people in the greater Maya world.

11.1 Dental Health of the northern Three Rivers Region

The poor preservation of the dentition at the three study sites resulted in data being collected from a total of 118 individuals. As a result, dental health was evaluated for approximately 53% of the study population. The features of the individual dental traits observed here include 15.3% with carious lesions with a total of 45% of the population having some form of caries. Individuals from Nojol Nah possessed the highest rate of caries (18.7%), followed by Blue Creek (12.2%) and Xnoha had the lowest frequency of caries (3.3%). Dental caries were the most prominent form of dental pathology recorded in the northern Three Rivers Region study. This is to be expected, as caries are the most common type of dental pathology recorded in most archaeological contexts (Roberts and Manchester 1997) and reflect overall dental hygiene and dietary factors (Hillson 2005; Roberts and Manchester 1997).

There were no significant changes in rates of carious lesions through time among the three sites. Typically in the Maya area, large differences in the rates of caries through time may occur. At Lamanai, White (1998) found that teeth in the Preclassic often had fewer caries than their Terminal Classic counterparts. Such patterning has been interpreted as largely due to the change of diet at Lamanai during the Terminal Classic, when the polity switched from a balanced diet to one that relied predominately on maize (Lund 2003: 11; White and Schwartz 1993).

That caries frequencies were evenly distributed between the sexes may be somewhat unexpected. It is often reported in the Maya region that females have significantly poorer dental health than males, and this includes rates of caries being more frequent for females than males (Cucina and Tiesler 2003). At Copán for example, as discussed in Chapter 3 (section 3.5.1a), Cucina and Tiesler (2003: 6-8) found that among the higher socioeconomic classes, females were more likely to have a higher rate of caries than males, suggesting a difference in diet or dental hygiene between Maya males and females of higher socioeconomic classes. In my research, such a difference between male and females was not present. The even distribution of caries may be a reflection of similarities in components of men's and women's diet in the region, perhaps reflecting equal access to food resources. Trade systems or the combined resources of the Alacranes and Dumbbell *bajos* may also have enhanced the range of resources available.

In contrast to caries, frequencies of calculus are different between males and females in this present study; females have greater frequencies of moderate calculus than males. This could be suggestive of at least a slight difference in either diet or oral hygiene between the sexes. In some areas of the Maya area it has been observed through dental analysis that males had access to significantly more variety in their diet, and that males did not have such a heavy reliance on maize as did females living in the same sites (Chase 1994; Cucina and Tiesler 2003; Marquez Morfin and Storey 2008). However, when it comes to caries, osteological evidence in the northern Three Rivers Region points to males and females appear to having had a similar (and varied) diet. This is also found to be the case at several sites along coastal and inland Belize (Marquez Morfin and Storey 2008;

Saul and Saul 1997). Given the locations of the northern Three Rivers Region sites, where there is no significant difference of rates of caries between male and females, access to and trade in marine and riverine food items may have played a large role in supplementing Maya diet.

At the Preclassic site of Cuello, Belize, nearly the entire skeletal population had varying degrees of calculus on a scale ranging from slight to severe, with no significant difference between males and females (Saul and Saul 1997). At Altar de Sacrificios, Seibal, Itzan, and the Petexbatun Region, incidences of calculus were infrequent and calculus was not well represented (Wright 2006). The northern Three Rivers Region skeletal population used in the present study more clearly resembles the populations of these latter sites in that calculus, while present, was not prominent. In contrast to caries, presence of calculus did in fact show a significant difference between the sexes; females had significantly higher instances of moderate calculus than males (Chapter 7.3.1). Calculus was the only dental pathology recorded in the study that affected males and females at different rates, and even this difference was observed only in cases of moderate calculus. The difference in dental calculus indicates that although there were no significant differences in rates of caries between males and females, there was in fact some slight difference in composition of the diet or of oral health care between males and females in the region. This difference in calculus could indicate a potential difference in diet; however hormones and other factors also influence the build-up of calculus. The overall difference in dental pathology between Maya males and females in this region was slight.

Comparing the number of teeth affected by caries with those affected by calculus is of interest since the two are often thought to have an inverse relationship (Hillson 1996). In the study sample, both pathologies are observed together with slight frequency. Of the 1083 adult teeth examined, only 28 teeth exhibited both caries and calculus. At the individual level this means that, of the 222 individuals, both adults and subadults in this case[13], 9 (4.1%) were affected by both caries and calculus. Seven of these had a combination of more than one

[13] As there was only subadult exhibiting both a carious lesion and slight calculus, it was combined in this sample rather than in the immature dentition sample.

carious lesion and a heavy build-up of calculus. While less than 5% is not a high frequency of overlap, the overlap that does exist between caries and calculus in the study sample likely has to do with the presence of maize in the diet, which can cause both caries and calculus (Cucina *et al*., 2003; Grimound *et al*., 2011; Healy *et al*., 1998; Hillson 2005; Mickleburg and Pagan-Jimenez 2012).

Linear enamel hypoplasia (LEH) had a low prevalence rate within the skeletal population of the northern Three Rivers Region when compared to other Maya sites. At Caracol, in southern Belize, enamel hypoplasia was found to be the most common pathology observed (Chase 1994). In her study of the Pasion populations, Wright (1997) found that 59% of the skeletons exhibited linear enamel hypoplasias. In the northern Three Rivefrs Region population however, enamel hypoplasia was observed in only 6.3% of the teeth. There is a range of proposed causes of LEH, poor childhood health, under- or mal-nutrition, socially induced stress factors, or stressors during weaning (Hillson 2005; Storey 1998; White 1997). The low LEH rate found within the study population is highly indicative of a population which had sufficient dietary nutrients, low stress and good overall health throughout childhood.

At the Maya sites of Copán, Cuello, and K'axob, amd the central Mexican site of Tlatilco, Marquez Morfin and Storey (2008) found that there was a significant increase of LEH and caries through time, particularly during the transitions from small settlements to larger cities, citing the increased reliance on agriculture as a leading cause. In North America, populations from Illinois during the Late Woodland period (800CE – 1100CE) showed similar trends in LEH, thought to be due to urban expansion and increased reliance on agriculture (Smith *et al*. 2016). In the northern Three Rivers Region, there was no significant increase in LEH through time. This suggests that this population was not exposed to any significant stress or dietary changes through time.

As previously stated, differences in dental health between the sexes is seen throughout the Maya region, with females consistently having poorer dental health than males, particularly in higher socioeconomic classes and throughout the region, dental pathology can become a much greater issue among various populations (Chase 1994; Cucina and Tiesler 2003; Leatherman 1998; Marquez

Morfin and Storey 2007; Seidemann and McKillop 2007; Scherer 2004; Wright 1997). In the northern Three Rivers Region we see three populations that had healthy dentition, as opposed to other areas in the Maya region. However, dental pathologies were still prominent in the study sample when compared to skeletal pathologies, and were still the most prevalent diseases affecting all three communities. The lack of starch and sugar build- up that leads to caries and calculus is likely due to the rich agricultural setting of this region. For example, the two large bajos in the area and their agricultural potential, and the rivers in the region that would have provided access to resources both locally and traded, may have played a role in the relatively low instances of caries and calculus because the Maya in the northern Three Rivers Region would have to have relied less on maize and other starch-based foods and would have the potential for a varied diet.

11.2 Skeletal Health of the northern Three Rivers Region

There were no significant differences in skeletal pathology among the three study sites of the northern Three Rivers Region. This section presents the results as they pertain to overall skeletal health of the northern Three Rivers Region. Firstly, degenerative joint diseases (DJD) will be discussed, followed by porotic hyperostosis, cribra orbitalia, skeletal trauma, and osteomyelitis.

A total of 30 (14.9%) individuals exhibited signs of DJD; Nojol Nah had the highest rates of DJD (21.7%), while Blue Creek had the lowest (7.3%), followed closely by Xnoha (8.8%). The affected individuals were older adults as is typical in Maya populations and elsewhere (Chase 1994; Weaver 1998; White 2006). The rate of DJD also follows an expected pattern as observed in other populations within the Maya region, especially when assessing remains that are of higher socioeconomic status (White 2006). Osteophytosis was the most commonly encountered expression of DJD in the study sample. Osteophytosis occurs as the initial stage of DJD and first appears in joints experiencing stress. In my sample, osteophytosis was recorded in the thoracic and lumbar vertebrae, in a number of hand and foot phalanges, and a few instances occurred in the patella.

Osteophytosis in the lumbar region is commonly observed, as the lumbar vertebrae are the most common site for osteoarthritis (Larsen 2003). Of the three sites Nojol Nah had not only the most severe cases but also had the highest proportion of arthritic individuals overall. Potentially, this could indicate that the population living at Nojol Nah had a greater number of physical stressors in their behaviour than the populations at Blue Creek or Xnoha. Even though all three of the site centres have exhibited, through archaeological evidence, high socioeconomic status, the population living in Nojol Nah may have been exposed to more intensive labour than at the other two sites (Brown *et al*., 2014; Guderjan 2015; Hammond 2015 . It is also possible that the higher instances of osteophytosis at Nojol Nah is genetic, perhaps pointing to Nojol Nah having integrity as a lineage, this hypothesis could be tested through DNA analysis.

Most maize-based porotic hyperostosis occurs in the Americas, as maize-based agriculture is prominent in New World societies (Blom *et al*., 2005; El-Najjar *et al*., 1976; Lallo *et al*., 1977; Masur 2009; Ubelaker 1992; Walker 1986; White 1999, 2006; Whittington and Reed 1997; Wright and Chew 1998; Wright and White 1996). However, the presence of porotic hyperostosis in relation to high maize consumption is not just limited to the New World; the correlation is observed in archaeological contexts worldwide (e.g. Brenton and Paine 2007; Djuric *et al*., 2008). In the Maya region porotic hyperostosis is on average seen in relatively high frequency, although the frequency varies greatly from site to site (e.g., 3% at Iximché to 77.8% at Chichen Itza; Masur 2009; Wright and White 1996). The northern Three Rivers Region study population fell into the lower range (4.5%) of frequency of porotic hyperostosis.

Whereas Maya sites such as Chichen Izta (77.8% of immatures, 52.9% of adults) and Copán (60% of adults) have a high frequency of porotic hyperostosis, lower percentages of porotic hyperostosis were found at Cuello (12.5% of immatures; 3.6% of adults), Iximché (3.1%), Lamanai (9%), and Tipu (19.4%), and may be due to less maize consumption or a more balanced diet, or different cultural practices (Wright and Chew 1998; Wright and White 1996). As presented in Chapter 2 (section 2.5), a maize-based diet can lead to porotic hyperostosis because the phytates in maize can inhibit iron absorption (Roberts and

Manchester 1997; Wright 2004). Phytates bind to iron (and other minerals such as zinc and calcium) and severely slow the absorption process. At Lamanai, there was an increase of porotic hyperostosis during the Postclassic, and this has been attributed to diet since it has been suggested that there was more maize being introduced into the diet during this time (Wright and Chew 1998). The northern Three Rivers Region more closely resembles the findings at Cuello, Ixiche, Lamanai, and Tipu, than at Chichen Itza or Copán. At Copán and at Petén sites, maize constituted up to 70% of Maya diet in the past and even today (Wright 2006: 109). However, in Belize and among Maya sites that could readily access marine and other food and trade resources, reliance on maize is not as ubiquitous. Therefore, the lower frequency of porotic hyperostosis in the northern Three Rivers Region is suggestive of a varied diet. Diets would have included foodstuffs such as fish, deer, peccary, turtle, and other animal proteins as well as crops including maize, beans, and squash, but also chillies, avocado and other vitamin-rich crops (Williams *et al*., 2009; White and Scharcz 1989). Owing to the low levels of porotic hyperostosis observed, it is evident that the Maya living in the northern Three Rivers Region relied on more than just maize as a dietary staple.

Since porotic hyperostosis is considered a childhood disease, the presence or severity of porotic hyperostosis can indicate that the child had a poor diet or grew up in an unhygienic environment. The expression of porotic hyperostosis in adults may be used as an indicator of whether or not there was differential treatment of one sex over the other in childhood. However, in the present study, no significant correlation was found between biological sex and presence or severity of porotic hyperostosis. This suggests that male and female children in the Three Rivers Region were treated equally in terms of dietary resources. At Copán, Storey (1998: 135) found that there were far more health differences between individuals of different status than between the sexes. However, it is also crucial to heed the warnings of the osteological paradox discussed by Wood *et al*. (1992); that male and female children in the northern Three Rivers Region had access to similar diets only holds providing that there is no significant difference in childhood mortality rate between the sexes.

In the present study, cribra orbitalia was observed in only 3.6% of the total skeletal population, and was found in similar rates among all three sites. As with porotic hyperostosis, cribra orbitalia was found to have no significant correlation with biological sex. Individuals with cribra orbitalia were found in different burial contexts, including subfloor burials as well as royal tomb contexts. Therefore, there is no significant correlation between cribra orbitalia and socioeconomic status within the northern Three Rivers Region skeletal series; instead, both cribra orbitalia and porotic hyperostosis affected individuals from all social tiers.

Neither porotic hyperostosis nor cribra orbitalia fit categorically into one known cause as both are non-specific health indicators. Like porotic hyperostosis, cribra orbitalia is observed throughout Mesoamerica at varying frequencies and is also considered to be a symptom of iron-deficiency anaemia (Saul 1972; Saul and Saul 1991; Scherer *et al*., 2007; Storey 1998; White *et al*., 1994; White *et al*., 2006; Wright 2006). As presented in Chapter 3 (section 3.5.4), Wright and White (1996) found that levels of porotic hyperostosis and cribra orbitalia were not as high at coastal sites as they were farther inland, and the authors argue that this is again tied to maize consumption, because maize comprises less of the overall diet at coastal sites. Since both porotic hyperostosis and cribra orbitalia were found in such low frequencies in the present study population, this further strengthens the argument that the people living in the northern Three Rivers Region had a varied diet and did not rely on maize as much as sites in the Petén.

A wide variety of skeletal trauma has been recorded in the Maya area, e.g., parry and cranial fractures, as well as post-mortem evidence of decapitation, and de-fleshing (Serafin *et al*., 2014: 140). The majority of studies completed on Maya skeletal trauma are based on case studies, and only a couple of regional studies have been undertaken, specifically as it pertains to warfare (Serafin *et al*., 2014: 140). There can be many causes of skeletal trauma: violence, accidents, osteoporosis, and deficiencies in vitamin C and other nutrients. In the northern Three Rivers Region, there were only eight cases of skeletal trauma observed, all of which were in the form of healed fractures. The fractures observed were mainly parry fractures located on long bones, metatarsals and pedal phalanges.

However, there was also one case of a well-healed fracture of the right mandibular ascending ramus (BC-54).

Due to the fragmentary nature of many remains throughout the Maya area, it is a typical occurrence within Maya skeletal assemblages to observe only healed fractures (Wright 2006: 186). It is therefore not surprising that all instances of the fractures observed in the northern Three Rivers Region study were well-healed. In her research on the Pasión Maya skeletal series, Wright (2006: 186) noted that trauma to the skeleton was 'rare' and that all the fractures noted were well-healed, as is the case in the northern Three Rivers Region.

Osteomyelitis was observed in three individuals. This typically occurs secondary to an infection and/or an open wound such as a fracture that penetrates through the skin. There was also only one case of periosteal reaction. In the Pasión Maya skeletal sample, Wright (1997: 270-271, 2006: 197) suggested that the high percentage of periosteal reactions (28% to 66%) may have been caused by tropical diseases, specifically yaws or leishmaniasis, the morphology of the lesions found in yaws closely resemble leishmaniasis. Yaws is acquired during childhood and caused by bacteria (*Treponema pallidium)* and spread through shared drinking vessels or human skin contact with an affected lesion (Asiedu *et al*., 2008; Rothschild and Rothschild 1994). If yaws becomes chronic, periosteal reaction can occur. Leishmaniasis is an infectious disease caused by numerous species of protozoans and spread by sandflies or mosquitos; if severe it can also result in periosteal lesions (Alvar *et al.*, 2012; Murray *et al.,* 2005). Regardless of the aetiology of the periosteal reactions, the very fact that they are present in a skeletal sample can provide a good indication of disease load within a population (Wright 2006: l96).

11.3 Stability Through Time: the case of the Three Rivers Region

The results of the northern Three Rivers Region skeletal study have illustrated relative stability in the health of the Maya in the region over time. With no great flux in disease frequencies, it is proposed that there were no deleterious changes in health or diet through time in this region, as would have effects on the skeleton. The northern Three Rivers Region had an extensive occupation period in

Maya history; based on ceramic analysis it is known that the region was inhabited from the Middle Preclassic through the Terminal Classic period (Beach *et al*., 2014; Guderjan 2007). The Late Classic in northern Belize and particularly in the Three Rivers Region saw population at its highest levels, due to an expansion in agricultural practices (Beach et al., 2014; Masson 2002: 336; Sullivan 2002: 200-201).

Steckel and Rose (2002: 3) state that 'Health is intertwined with demographic social, economic, and political change and with the outcomes of wars and other conflicts.' During the ancient Maya occupation of the northern Three Rivers Region, archaeological evidence suggests that there was little demographic or economic stress, and the health patterns observed in my skeletal study support this hypothesis. In the Early Classic there was an event which 'marked a turning point' in the history of Blue Creek (Guderjan 2007: 45-46). This is evidenced by a jade large cache at the Blue Creek site core at Structure 4, which is quickly followed by the conversion of the Structure 13 Courtyard group to a secular residence from a sacred space, and the razing of Structure 1. These changes could have been caused by numerous factors: the demise of a ruling lineage, warfare, or a rejuvenation of leadership of some kind (Brown *et al.*, 2014; Guderjan 2007, 2015; Hammond 2013, 2015).

The burials from Blue Creek that date to this timeframe do not exhibit any indications of comparatively poorer health than other individuals in the dataset. The event mentioned in Chapter 4 (section 4.3), at Nojol Nah and the smaller site of Tulix Mul, occurred during the end of the Early Classic (Guderjan 2015: 13). This event is marked by the halt of construction at Nojol Nah as well as the filling in of a large *chultun* under Structure 4C11 at that site, and the sealing off of two vaulted rooms at Tulix Mul (Brown *et al.,* 2014; Guderjan 2015; Hammond 2015). Guderjan (2015: 13) posited that perhaps these two architectural changes indicate that during the Early Classic, Xnoha was expanding and gaining political control, thus political power at Nojol Nah may have been waning during the Early Classic as Xnoha's political control grew. However, as the previous chapters have illustrated, there does not seem to be any large alterations in health patterns corresponding to these potential shifts in political control.

In the Maya lowlands during the Early Classic, Tikal and Calakmul were large centres of political power and control. However, by the end of the Early Classic, for roughly one hundred and fifty years, there was political friction in the Petén (Sullivan and Sagebiel 2003). This time is known as the 'hiatus', and is marked by a cessation in the construction of monuments within the Petén (Sullivan and Sagebiel 2003: 31). The hiatus was due to a variety of causes, including warfare between Tikal and Caracol, which resulted in a weakening of Tikal's regional power and a defeat of Tikal by Calakmul (Sullivan and Sagebiel 2003).

Despite this 'hiatus' of the end of the Early Classic period, by the time of the Terminal Classic, the northern Three Rivers Region is found to be less affected than other areas of the Maya world. In regards to north-eastern Belize, Masson (2002: 336) argues that during the collapse of the southern lowland Classic sites, the populations in north-east Belize were one of the least affected. The same can be said of the populations of northwestern Belize. The reasoning behind this again is the physical location of the region itself: its proximity to coastal trade routes and resources.

Even with these different events, particularly those taking place within the study sites themselves, whatever the events might have entailed, the overarching theme assessed is that the Three Rivers Region as a whole was very demographically and economically stable through time. Even while events changed the political landscape around the Alacranes and Dumb-bell *bajos*, overall health and population growth continued to remain stable (Beach *et al*., 2014; Brown *et al.,* 2014; Guderjan 2015; Hammond 2015).

11.4 Health and Status in the northern Three Rivers Region

Maya socioeconomic status is a topic that has received much attention for the better part of a century (Argo 2010). This is largely due to paradigm shifts in the study of Maya archaeology and the changing of archaeological and anthropological thought through time (Argo 2010). When Maya archaeology first began, research focused on monumental architecture and the artefact assemblages found therein. Willey's (1956; 1965) work in the Belize Valley shifted focus from monumental architecture to settlement archaeology. In the 1980s, with survey work such as the Copán PAC II project, the mapping and excavation of small house mound sites sparked further interest in settlement amongst archaeologists (Webster *et al.*, 2000: 32-35). Medium-sized archaeological sites however, still did not receive much attention (Argo 2010). Beginning in the late 1980s and early 1990s, medium-sized Maya sites began to be explored which allowed for a more complete understanding of Maya economic hierarchy.

Status, while typically quite difficult to define in the archaeological record, is particularly challenging in the northern Three Rivers Region and Mesoamerica as a whole. The reasons are: 1) the general lack of grave goods found in association with burials, due to either a lack of placement within the burial originally or to burial goods being perishable (such as textiles) and 2) elaborate grave goods and other artefacts found in burial contexts which would otherwise be considered as non-elite or rural in nature, (for example the burial of BC-SH-2 at Sayap' Ha, discussed later within this chapter [section 11.8]). As Ucko (1969: 267) states, 'paucity of burial goods does not necessarily imply a low level of material wealth,' thus creating a grey area in burial analysis, where direct correlations cannot be inferred. This is a topic that will be discussed in greater detail in section 11.8 of this chapter.

For these reasons, socioeconomic status is difficult to determine in this region. However, the economic status in the northern Three Rivers Region is considered to be generally quite high for the area based on the scale of monumental architecture and quality of material artefacts (Guderjan 2007). Despite this, considering of Mesoamerica as a whole, the economic wealth becomes relative. The sites in the central Petén during the Classic Period -- or indeed the sites along the northern Yucatan in the Terminal and Post Classic periods -- greatly overshadow the northern Three Rivers Region in terms of political and economic control (Guderjan 2007; Sullivan 2002).

As discussed previously in Chapters 2 and 4, the inhabitants of the study area were in a position to take part in riverine trade networks. The bajos, Alacranes and Dumbbell, provided an area of rich agricultural systems. With some exceptions, including Lamanai (Graham 2011; Masson 2002), the Classic period saw political power focused in the lowlands before shifting to the northern Yucatan Peninsula (Sullivan 2002). This means that for much of ancient Maya history, the Three Rivers Region was in the centre of the Maya political and social world.

Due largely to the contexts of the burials in the northern Three Rivers Region study, as well as excavation strategies and methodologies, it is hypothesised that the skeletal population is composed of individuals belonging to the ruling elite, non-ruling elite, and sub-elite socioeconomic classes but, aside from perhaps a few exceptions from the Blue Creek farming community Chan Cahal, does not include commoners. Most of the 222 skeletal remains were found in elite and sub-elite contexts, that is from within elite and sub-elite structures. The ways to define whether a structure is an elite residence are three fold: location, form, and construction type (Pendergast 1992: 63). Examples include evidence such as the structure's size or building material as well as the masonry of the structure (e.g., corbelled arches). These criteria further strengthen the idea that the skeletal study population largely does not include commoners and those of the lower classes (Guderjan 2007: 74-76).

Maya city centres were city-states (Grube 2000: 547-551; Marcus 1993). However, while these cities functioned as separate entities they were also interconnected; not simply through trade but through political alliances. Even though medium-sized, Blue Creek and Xnoha -- Nojol Nah is currently thought to have been slightly smaller -- would not necessarily have had the great political power or force of Tikal, Caracol, Calakmul and other larger Maya city-states. Martin and Grube (2000) suggest that because Calakmul is only approximately 50 kilometres from the Three Rivers Region, the southern lowland Maya political alliances would have been affected by the rivalry between the major polities of Calakmul and Tikal. Thus, warfare would have been largely dictated by the larger cities and their political climate would have had influence on the many other Maya centres in the lowland region.

However, that is not to say that the northern Three Rivers Region, in particular the site of Blue Creek itself, was completely devoid of political power or prestige. The Rio Bravo escarpment, which towers over the flat limestone plateau of northern Belize, may not have been just a physical boundary but also perhaps acted as a cultural gateway (Barrett 2004). Indeed, as Barrett (2004: 91) states, 'while commercial and elite interaction undoubtedly occurred between north-western and northern Belize sites, differences in political allegiance and cultural tradition have been proposed for the two regions.' Barrett (2004: 91) went on to say that, 'Thus, by virtue of its location, Blue Creek was not only one of the easternmost bastions of the central Petén cultural tradition (and perhaps political sphere), but it was also well-positioned as a liaison community between the two zones.' If Barrett is correct in his supposition, then due to their location, all three study sites would have been well positioned within the Maya socioeconomic world.

In Blue Creek, a number of socioeconomic classes are believed to have been represented based on data from excavations; Guderjan (2007: 65-66) observes that 'each discrete component of the Blue Creek polity exhibits extremely diverse characteristics and is unlike all others.' For example, as discussed in previous chapters, Kin Tan was an area of non-ruling elite residences, while Chan Cahal (refer to Figure 4.2) was a farming community. However, this may not be completely accurate as Chan Cahal housed one of the largest caches of jade ever found within the Maya area. This jade assemblage acts as a clear reflection of great wealth, which could mirror the relationship of the working community with that of the elite classes and the political economy of Blue Creek as a whole (Guderjan 2007: 66)

At Piedras Negras, Scherer and colleagues identify four status categories: commoner, intermediate, elite, and royal (Scherer *et al*., 2007: 88), variations of which were discussed in Chapter 2 (section 2.5.1). While the northern Three Rivers Region has similar classification system, the categories are slightly skewed due to the nature of the three sites: they are mid-sized as opposed to the larger site of Piedras Negras, and while Piedras Negras is situated in the northwest corner of present day Guatemala, near the Tabasco and Chiapas regions of Mexico, the Three Rivers Region is located at the periphery of the Petén and is considered to be a more rural area during the time of occupation (Guderjan 2007). For these reasons, while the status categories are similar, they are imbued with inherent differences as the material manifestations of the categories are varied. For example, A ruler's burial at Piedras Negras differs largely in terms of burial architecture and associated grave goods compared to a royal burial at Blue Creek. Piedras Negras shares some similarities with the sites in the northern Three Rivers region in that associated grave artefacts were uncommon amongst the excavated burials, and burial goods were found to be scarce even in royal elite tomb contexts (Houston *et al*., 2003; Scherer *et al*., 2007: 88).

In Mesoamerica, the identification of status is based largely on burial location within public or private space (Wright 2006: 43). For this reason, as well as the quality of the architecture of the buildings in which the northern Three Rivers Region dataset were excavated, the data largely represent only the highest tiers of ancient Maya society in this region: the ruling and non-ruling elite and sub-elite. While the skeletal population does not provide a complete view of the living population of the three sites, it does provide an in depth view of the higher statuses in this region, creating a larger baseline for the skeletal study of the ancient Maya rural elite. The notable exception to this is the Blue Creek farming community of Chan Cahal; however the many of the individuals from Chan Cahal were too poorly preserved to assess substantial osteological information.

With increasing social complexity comes unequal access to resources and wealth, as well as increases in urban populations (Marquez Morfin *et al*., 2002: 335). However, in the northern Three Rivers Region, frequencies of health and disease are similar within and between the three study sites. This was also the case at Copán where, through isotopic analysis, it was learned that socioeconomic classes had little effect on diet (Webster *et al*., 2000: 132-135). Indeed, Webster and colleagues (2000: 135) state that 'to a degree that is surprising in such a hierarchically structured society, people of all social ranks and statuses seem to have broadly shared similar health hazards and diets'. There was little difference seen in correlation between health and status at Piedras Negras (Scherer *et al*., 2007), which is also true of the northern Three Rivers Region study. As discussed in section 11.8 below, analysis proved that for this present study there were no significant differences between social groups, apart from one instance in dental pathology.

11.5 Health and Biological Sex in the Three Rivers Region

Health as it relates to biological sex is a topic much discussed in the osteological literature (e.g. Cucina *et al*., 2003; Cucina and Tiesler 2003; Cybulski 1988; Fairgrave and Molto 2000; Leatherman 1998; Storey 1998; Stuart-Macadam 1998; Wapler *et al*., 2004; Wright 2006). When paired with age and sex data, health indicators can be used in a number of ways to aid in the understanding of past cultures. When discussing biological sex, it would go amiss not to examine the cultural construct of gender: biological sex is information that can be surmised through osteological analysis, whether someone is biologically male or female, while 'gender' is a social construct, defined by an individual's cultural norms. Mesoamerica has long acted as a focus for archaeologists interested in gender studies (e.g., Conkey and Spector 1984; Joyce 2006).

In Mesoamerica, gender studies have employed the works of anthropologists, archaeologists, ethnographers, and osteologists. Osteology can play a role in assessing gender roles, for example wear patterns on the patella, ulna and humerus of biologically female skeletons have indicated that the process of grinding maize was primarily women's work (Goodman and Martin 2002; Wanner 2007). Cultural norms can be misleading, and the social environment of the researcher can also impact results for all of these reasons; therefore, the northern Three Rivers Region study strictly employed the osteological evidence for biological sex rather than inference of gender based on artefact assemblages.

Archaeological and iconographic evidence strongly suggest that Classic Maya males and females shared similar social status (Joyce 2000; Williams and White 2006: 141). However, there is evidence for differences in diet between males and females throughout the Maya region. At Altun Ha (White *et al*., 2001), Copán (Storey 1992), Pacbitun (White *et al*., 1993), and numerous other Maya sites (White 2005; White *et al*., 2008), there is strong osteological evidence for preferential treatment of males over females in terms of dietary intake. The Maya living in the northern Three Rivers Region during the Preclassic and Classic periods do not seem, based on the present research, to have practiced such dietary preferential treatment. Patterns revealed in the northern Three Rivers Region study did not conform to patterns found in previous studies; however, the results do mirror those found at other sites in northern Belize, including Lamanai (White *et al*., 1994), San Pedro, and Ambergris Caye, just off the coast (Williams *et al*., 2009). As this pattern is found throughout northern Belize, from San Pedro to the Three Rivers Region, with the notable except of Altun Ha, listed above, the pattern could again be accounted for if we turn to look at trade access and crop variety (Beach *et al*., 2014; White et al., 2001). Perhaps the Altun Ha exception could have less to do with trade and agriculture and more to do with socioeconomic status. It is likely that in the northern Three Rivers Region, there was no preferential dietary difference between the sexes due to an abundance of resources and no need to discriminate between males and females. It could also indicate, as discussed in section 11.3 of this chapter, that social stressors including conflicts, warfare, and power shifts could have had less effect in this region than in other areas of the Maya realm.

11.6 Cultural Modifications to the Skeleton and Health Patterns

All three of the study sites had examples of skeletal modification, both cranial and dental. The tabular erect, or fronto-occipital, flattening style of cranial modification was the sole type of cranial modification observed throughout the dataset. This is somewhat unsurprising, given that fronto-occipital flattening is the more common of the two types of cranial modification seen in the Maya region, the other being the less prevalent tabular oblique style (Tiesler 2010; White 1996). Fronto-occipital is also the prevalent style of modified crania in northern Belize. For example, at Lamanai, fronto-occipital flattening is the dominant style and it is suggested that the few crania which exhibit lambdoidal flattening might have been immigrants from elsewhere in the Maya region (White *et al*., 2009: 169). Throughout the dataset biological sex had no significant effect on whether or not an individual had cranial modification.

The percentage of modified crania for the Nojol Nah population (29.9%) is vastly greater than both Blue Creek (7.0%) and Xnoha (5.0%). This could have more to do with the good preservation of the crania found at Nojol Nah however, than any true difference in cultural tradition. As mentioned previously, the preservation of human remains found at Nojol Nah is often good to excellent, whereas the Blue Creek remains tend to be highly fragmented and in poor states of preservation, and at Xnoha the preservation of the skeletal sample is fair to good.

Currently, there seems to be no strong relationship between cranial modification and frequency of pathology; that is, head shaping has not been found to affect rates or severity of health indicators (Duncan and Hofling 2011: 201). However, again at Lamanai, there seems to be a statistical association between individuals who practiced cranial modification and the presence of wormian bones along the lambdoidal suture, along with premature sagittal synotosis (White (1996: 397). The northern Three Rivers Region skeletal population was largely too fragmentary to run a similar statistical analysis.

The northern Three Rivers Region yielded a variety of dental modifications. Numerous studies (e.g., Saul and Saul 2001; Williams and White 2006) have shown that there is no large difference in the rates of dental modification amongst males and females and similar results were observed in the northern Three Rivers Region study. Of the dental modification variations, Molina type B4 was the most common typology among the Blue Creek and Nojol Nah populations, which is in line for the typology of the region during Preclassic and Classic periods (Williams and White 2006). At Xnoha no instances of the B4 type were observed. However, Xnoha only had three individuals present within the study sample, for a total of nine teeth, so it is possible that small sample size could be the reason for this divergence from the regional trend.

According to Duncan (2009: 179), 'Unlike researchers working in other areas, Mesoamerican researchers have spent less time considering potential health repercussions stemming from cranial modification.' In Chapter 9, an attempt was made to provide some results in order to address that issue while expanding the topic to examine the health implications of dental modifications. In both cases of modification types however, there was no significant correlation of health indicators to either variation of cultural skeletal modification. The studies of this correlation often conclude that there is no adverse effect on health caused by cultural bodily modifications (Duncan and Hofling 2011: 200). However, an exception is found at Lamanai where correlations between filed and inlayed dentition and carious lesions have been recorded (Williams and White 2006). This could have to do with the inlays reaching the pulp cavity of the tooth in some instances. In the northern Three Rivers Region, inlays reaching to the pulp cavity were not observed.

11.7 Funerary Rites in the northern Three Rivers Region

Maya funerary practices during the Preclassic and Classic periods are discussed here as many of these were seen in the northern Three Rivers Region. As clarified in Chapter 10, there were different types of interments, although subfloor burials within household structures comprised the majority among all three sites and throughout the region's occupation history. In the northern Three Rivers Region, subfloor burials comprised nearly 74% of the burial types observed in this study. Throughout the larger Three Rivers Region and the Maya area as a whole, subfloor burials comprise the majority of burial types (Chase and Chase 1996). A sample from the greater La Milpa area in the Three Rivers Region found that over 87% of the skeletal population was excavated from subfloor burial contexts (Geller 2012).

In the present study secondary burials were found in only seven cases, and all of them at Nojol Nah. Secondary burials are present throughout the Maya region (McAnany *et al.*, 1999; Tiesler 2007: 26). In northern Belize during the Terminal Classic period, McAnany and colleagues (1999: 132) state that there was a 'mortuary pattern that includes a central primary interment associated with the partial remains of at least one other individual'. Thus there were instances of not just a joint burial but of a primary burial combined with a secondary one, and repeated use of the interment over time. In the northern Three Rivers Region study, the inclusion of only seven instances of secondary burials, again all of them from Nojol Nah, could indicate that this practice, while observed in northern Belize, was not as prominent in the northern Three Rivers Region as elsewhere in Belize. As mentioned in chapter 4 (section 4.3) there is evidence that the Nojol Nah population came from an area near Naranjo. Therefore, perhaps this cultural difference could be the reason there are some secondary burials at Nojol Nah but none are found at Blue Creek nor at Xnoha.

As mentioned in Chapter 2, ceramic vessels have been recorded throughout the Maya region as being placed over the cranium of the deceased, particularly during the Late Preclassic period. Typically, when this occurs, a 'kill hole' is also present in the centre of the vessel. If a kill-hole is present in the ceramic, occasionally piece of jade is found in the jaw of the deceased. Taube (2005) suggested that the jade piece is representative of the breath of the deceased individual (Guderjan 2007: 77). However, in the northern Three Rivers Region, while 'kill-hole' ceramics were widely used and were indeed placed over the face of the deceased, they usually do not include a jade piece[14].

An additional funerary rite was the application of minerals such as red ochre, or haematite, or cinnabar to the body of the deceased. It has been suggested that the inclusion of haematite or cinnabar in funerary contexts could be indicative of the burial belonging to a member of the ruling elite (Couch 2015; Cucina and Tiesler 2004, 2006; Fitzsimmons 2009 Quintana *et al*., 2014). The application of haematite or cinnabar to elite burials is a practice that spanned at least 2,000 years of Pre-Columbian history (Quintana *et al*., 2014). Cinnabar, ore of mercury, is formed in sedimentary and metamorphic rocks, and in low tempiture geological viens (Beach, pers. comm 2017; Rytuba 2003: 13). In Central America cinnabar is found in regions of the highlands of El Salvador, Guatemala, Honduras, and the Chiapas region of Mexico, and was procured in the lowlands through trade (Quintana *et al*., 2014). Haematite is typically from the Maya Mountains. The skeleton of K'inich Janaab' Pakal of Palenque was found with cinnabar (Cucina and Tiesler 2004, 2006), as were other members of the ruling elite at Tikal, Tonina, and elsewhere (Fitzsimmons 2009: 81). The same is true of haematite, in fact, Fitzsimmons (2009: 217) state that burials found with haematite are 'too numerous to cite.' Even though haematite is typically found over the entire skeleton, there are cases where just the cranium is treated (Fitzsimmons 2009: 82).

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[14] However, there were a few exceptions found in the assemblage, such as BC-KT-45; see Appendix A.

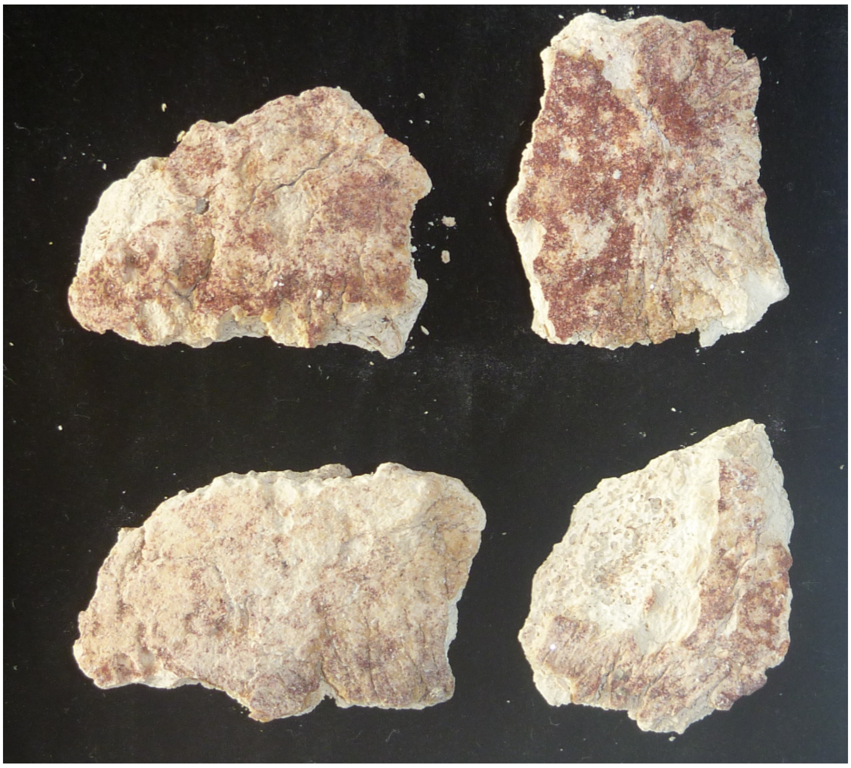

Figure 11.1: Cranial fragments with red ochre, Burial NN-26; photo by the author.

This is the case with the haematite found in the burial context of NN-26, illustrated in Figure 11.1. NN-26 was estimated to be an adult male between the ages of 30 and 40 years old. There are two other cases of haematite seen in the skeletal assemblage, NN-28, and BC-34; the latter was presented in the context of Tomb 5 of Blue Creek (Chapter 10 section 10.3.1). NN-28 had haematite present on rib fragments. NN-28 was exhumed within the same structure (Structure 5E6 at Nojol Nah) as NN-26 and NN-25; the latter did not have any haematite present however. Biological sex did not seem to be an explanatory factor as both NN-25 and NN-28 were females over the age of 40 at the time of death.

Following the theory presented by Fitzsimmons (2009) it can be questioned whether or not the individuals buried within structure 5E6 were ruling elite. The structure in which the burials were discovered is part of a large plazuela at Nojol Nah, and Barrett (2010: 61) delineated this complex as a 'palace structure' (refer to Figure 4.16) and that 5E6 is the largest complex in the area. It is also the most centrally located area within the site core of Nojol Nah, and for these reasons 5E6 could perhaps have been the residence of the site's 'most influential' lineage (Barrett 2010: 61). The presence of red ochre on some of the skeletons could support this hypothesis.

There are many theories as to the causality behind the placement of red ochre within burial contexts. Many have considered that worldwide the colouring of red ochre signified blood, or was applied to make the deceased look more life-like (e.g., Fitzsimons 2009; Marshack 1981; Taçon 2004; Watts 2002; Zagorska 2008). It is often difficult to determine if the colouring was applied directly on the bones, or if it was applied to the skin and indirectly coloured the bone, and there are known cases of both methods having been practiced (Fitzsimmons 2009: 82).

In terms of the effectiveness of burial analysis in providing cultural information archaeologically, Parker Pearson (2003: 21) states:

> The presence of grave goods does not necessarily imply belief in an afterlife; the orientation of a buried corpse might not reflect ideas about the direction of the other world; cremation need not imply any belief in the existence of a soul after death; and dynastic tombs need not indicate royalty. Such is the extent of cultural diversity in dealing with death that any generalization is certain to founder because at least one society would be known to social anthropology to break the rules.

The presence of burial goods may not reflect material wealth. For example, a large jade cache was excavated at the farming community of Chan Cahal, although this was not in a burial context (Guderjan 2007: 111). Located at the bottom of the Bravo Escarpment, Chan Cahal is thought to be one of the least economically advantaged *barrios* of Blue Creek area; the house structures were constructed of perishable materials. The jade found at this site could perhaps indicate a relationship with the elites and the political economy (Guderjan 2007: 66) or even that it was stolen or similarly completely out of context. It is due to cases such as Chan Cahal that blanket statements about material wealth and economic status cannot be made lightly in regards to the Maya region, that there are exceptions and intricacies which we do not yet fully understand.

An example of elaborate burial goods found in peculiar context is found at Sayap' Ha (for further information on Sayap' Ha refer to Chapter 4.2.7). The grave goods in burial BC-SH-2 included 653 pieces of chert, 46 pieces of obsidian, an animal bone carved into the form of an anthropomorphic head, and two inlayed shell disks placed on either side of the skull (Figure 11.2). Large quantities of obsidian flakes have also been found in the context of tombs at the Blue Creek site core in Structure 24, as well as the nearby sites of La Milpa and Kakabish, both in the Three Rivers Region (Guderjan 2009: 128). The difference however, between Structure 24, and the burial at Sayap' Ha, is that while Structure 24 is a monumental structure and the obsidian excavated came from a heavily looted tomb, the Sayap' Ha burial was a household structure. While Sayap' Ha was still close to the site core and likely inhabited by non-ruling sub-elite, the presence of this scale in grave goods is somewhat unexpected and ties into the concept that burial wealth and living wealth can greatly differ.

Figure 11.2: The inlayed shell disks and beads, and anthropomorphic head, found in association with Burial BC-SH-2; photo courtesy of the Maya Research Program.

Burial analysis has been and continues to be a source for archaeologists to assess information about past people, both in terms of osteological as well as social analysis (Robin 2001: 18). While burials and grave goods might not have a direct correlation to day-to-day life (Parker Pearson 1982), they still lend themselves to study of past cultures and society through a myriad of aspects. The symbolism, as touched upon in Chapter 2 of the objects themselves, even the materials they were made of can be incorporated into our understanding of Classic Maya culture. Belief systems and trade networks can be at least recognized through the examination of burial culture. In his work on mortuary practices and prehistoric social systems, Tainter (1978: 106) describes differences in social identities and how these identities can be represented through burial analysis, he states that:

> In egalitarian societies infants will have few social identities, whereas adults will have acquired many. Drawing from this principle, Saxe (1970: 8) points out that, if archaeologists find infants buried in a manner indicating a social persona larger than that possessed by some adults, a principle of social ranking by birth is probably indicated.

In this way, social status can be surmised through burial accoutrements. The same materials can have different meanings when combined in burial assemblages. As an example: throughout the Classic period, obsidian is often found in the context of elite burials and ceremonial structures, while when excavated in the context of commoner household groups it is most often found in midden contexts (West 2002: 151). This suggests that perhaps obsidian had different functional significance depending on context; in elite populations it was considered an item of prestige whereas in lower status communities it was a utilitarian item (West 2002).

In terms of how health indicators relate to funerary rites and burial type, these archaeological features are used in part to determine socioeconomic status. There are cases of populations in the Maya area of higher socioeconomic status having fewer cases of dental and other pathologies (Storey 1992). As proven in Chapter 10, in the northern Three Rivers Region this typically was not the case. Rather, individuals exhumed from areas hypothesised to be of higher socioeconomic status had the same general health patterns as those individuals from lower socioeconomic status. The exception found in the northern Three Rivers Region study was in frequencies of LEH, with a greater percentage of LEH recorded at the Nojol Nah site core. The majority of cases of LEH (86.6%) at the site core of Nojol Nah date to the Early Classic period. What makes this case interesting is that the Nojol Nah site core has been deemed through archaeological assessment, along with Kin Tan, Tulix Mul, the Blue Creek site core, and the Xnoha site core, one of the economically privileged areas in this study. As discussed in section 11.3 of this chapter, at the end of the Early Classic period, Nojol Nah underwent a shift; this early city-state either shifted political alliance, or perhaps the ruling lineage was terminated. Either way the end of the Early Classic for Nojol Nah saw changes, one of them being a lower frequency of dental pathology (specifically LEH) after the end of the Early Classic.

11.8 Health of the Ancient Maya: the northern Three Rivers Region in Context

With their research at Piedras Negras, Scherer and colleagues (2007) compared various health indicators across Maya sites and timeframes: the Pasión region, Copán, Cuello, Playa del Carmen, Tipu, and crania from Chichen Itza. The authors state that instances of porotic hyperostosis were rare in the Belize and Yucatan sites compared with elsewhere in the Maya region. They suggested that this may be related to more variety in diet as there would be greater access to marine and riverine resources and less reliance on maize (Scherer *et al*., 2007: 95). What the authors discovered was that the inland sites of Piedras Negras, the Pasión region, and Copán had the highest prevalence of porotic hyperostosis among the sites in their study and the sites in Belize and the Yucatan had the lowest (Scherer *et al*., 2007).

When evaluating the dental data of Piedras Negras, Scherer and colleagues found that frequencies of caries remained constant over time (Scherer *et al*. 2007). It was also discovered that out of all of the sites in their study, those in Belize and the Yucatan (with the exception of Colha) had markedly lower rates of caries than sites in the Petén (Scherer *et al*., 2007). At both Copán, Honduras, and at Lamanai, Belize, higher status individuals were found to have suffered less from caries than those individuals of lower socioeconomic status (Cucina and Tiesler 2003: 2). In their study on dental pathology in the northern Petén among the Classic Maya (specifically Calakmul, Dzibanche, and Kohunlich for a complete sample size of 49 individuals), Cucina and Tiesler (2003) found that lower frequencies of caries were observed in high status males than in high status females, suggesting that the males of this region had greater access to foods that were less cariogenic (Cucina and Tiesler 2003: 6). The authors state that this is indicative of access to food not being simply an issue between the classes at these sites, but also between the sexes belonging to the same class (Cucina and Tiesler 2003: 6). On Wild Cane Cay, off of the coast of Belize, Seidemann and McKillop (2007) found that the results of analysis of adult dentition of a Postclassic Maya skeletal population upheld the argument for coastal sites having healthier diets than sites located farther inland.

In the northern Three Rivers Region, both dental and skeletal indicators pointed to a relatively healthy population. Caries were the most often recorded dental health indicator. It appears that overall dental hygiene across all three sites was similar, and the region was less affected by poor dental hygiene than some other areas of the Maya region (Chase 1994), although for the larger northern Belize area, this appears to fit the trend in dental health (Seidemann and McKillop 2007). As mentioned earlier in this chapter (section 11.3), health indicators of the skeletal population of the northern Three Rivers Region suggest little change in health patterns across the dataset. The results of the northern Three Rivers Region study are indicative of the skeletal population in this region being comparatively healthy between the sexes, across social tiers, and throughout the occupation history of the region.

This trend towards in health patterns is, as discussed in section 11.4 of this chapter, fits with what is known archaeologically about the region (Guderjan 2015; 2007; Masson 2002). That is, with this region acting as a gateway into the Petén from the Caribbean, it was likely less affected, or affected differently, by political strife taking place in the Petén. Also, the very environs of the northern Three Rivers Region likely played a large role in sustainable health. With the two large Alacranes and Dumb-bell *bajos* located in the region, and the popularity of the use of ditched field agriculture throughout the northern Three Rivers Region, as well as the availability of river trade, the people living in the area are proposed to have had access to a varied diet and trading opportunities, and therefore the trend towards a healthy skeletal population fits with what is known of the region as a whole.

Chapter Twelve

Conclusion

The study of disease and indicators of health in the past can give us great insight into past society and culture. Even with the small sample sizes typical of osteological databases, questions regarding health in the past can still be answered. The research presented in this thesis aimed to determine whether the northern Three Rivers Region differed in various health aspects within and among three specific sites, as well as to compare the health of those sites to the larger Maya region, and present some hypotheses as to why differences occur, if in fact they do at all.

Overall, the northern Three Rivers Region skeletal population is devoid of any large differences in disease prevalence through time or between the sexes, indicative of populations that are fairly stable in terms of health and disease. These patterns hold throughout the dataset: among all three sites combined, as well as each individual site. Presence of stress-related pathology was found in low frequency, suggesting there were lower rates of chronic stress when compared to other contemporaneous Maya populations deeper in the Petén.

The various health indicators recorded throughout the study were indicative of a population whose overall health was consistent through time. Chronological fluctuation in health reported at many other Maya sites was not observed among the northern Three Rivers Region sites. Moreover, differences in disease rates of the sexes are few, suggesting comparable health experience between males and females. This general equity in health between the sexes and through time is proposed to be associated with the accessibility of trade networks in the region and access to a wide range of resources. This access to resources, combined with the agricultural systems in the area – the use of ditched fields and *bajos* – presumably afforded the people of the northern Three Rivers Region a great variety in diet. Among many Petén sites, favouring of males over females is indicated by significant differences in dental pathology and through the assessment of stable carbon and nitrogen isotopes (Storey 1992; White *et al*., 1993, 2001). In contrast, among the northern Three Rivers Region sites, it does not appear that the sexes were treated differently, either as a result of cultural practice, or in extreme circumstances when resources were limited.

Results of the analysis of dental pathology within and among the three sites show a low frequency of linear enamel hypoplasia. The location of the sites along the Bravo Escarpment in the Three Rivers Region would likely have provided the populations of the region with a varied diet, and thus could have served to buffer children against repeated periods of physiological stress. The low numbers of stressors evident in the sample were not likely caused by chronic under- or malnutrition, due to the proposed dietary resources in the region. A healthy weaning process and a nutrient-rich diet would contribute to the low amount of childhood stressors in the region as indicated by the study sample.

While this research has evaluated the health of the northern Three Rivers Region using macroscopic methods of skeletal analysis, there is more that could be added by the employment of other forms of osteological assessment. I used macroscopic observations to identify pathological conditions. However, there is still much information on health in the region that can be obtained through other methods such as use of radiographic and histological techniques. The latter would be especially useful to further the assessment of cribra orbitalia in this skeletal population and thereby allow cases of cribra orbitalia unseen macroscopically to be assessed (Walker *et al*., 2009; Walper *et al*., 2004).

Investigations into stable isotope analysis of the skeletal population of the region would allow for other factors to be distinguished. For example, differences in diet among socioeconomic statuses have been observed through isotopic analysis elsewhere in the Maya region, i.e. at Lamanai (White *et al*., 1994), Copán (Whittington and Reed 1997) and Altun Ha (White *et al*., 2001). Finally, population movements and migrations have yet to be explored in the region. This could be accomplished using strontium and oxygen stable isotopic analysis to investigate movement within and into the northern Three Rivers Region. In particular, a comparative stable-isotopic analysis of the Nojol Nah population and the skeletal population of Narajano in Guatemala would be useful. While isotopic methods can only detect immigrants, the comparison of skeletal populations could attempt to prove or dispute the hypothesis put forward in Chapter 2 that the Nojol Nah population originally migrated from the Narajano area (Guderjan *et al*., 2015) and offer insight into the migration of the Preclassic Maya of the region. A strontium baseline for the northern Three Rivers Region is in the process of being created by Dr. Katharine Miller-Wolf and me, which will facilitate research into population movement in the near future. On a larger scale, outside of the Three Rivers Region there is still much to be learned from the study of health in Mesoamerica. While it is my hope that the northern Three Rivers Region study has contributed to the corpus of knowledge in that regard, there is still much to be done in the study of skeletal health indicators in this region and the interplay between culture and health in archaeological contexts.

References Cited

Abrams, Elliot, 1994. *How the Maya Built Their World*, University of Texas Press, Austin

--- 1998. 'Structures as Sites: The Construction Process and Maya Architecture.' *Function and Meaning in Classic Maya Architecture: A Symposium at Dumbarton Oaks 7th and 8th October 1994*, ed. Stephen Houston. Dumbarton Oaks Research Library and Collection, Washington D.C

Acsádi, G., Nemeskéri, J. and Balás, K., 1970. *History of human life span and mortality* (pp. 255-256). Akadémiai Kiadó.

Agarwal, Sabrina C., 2012. 'The Past of Sex, Gender, and Health: Bioarchaeology of the Aging Skeleton,' *American Anthropologist,* Vol. 114 No. 2 pp. 322-335

Aimers, J.J., 2007. What Maya collapse? Terminal classic variation in the Maya lowlands. *Journal of archaeological research*, *15*(4), pp.329-377.

Andrews, A.P., Andrews, E.W. and Castellanos, F.R., 2003. The northern Maya collapse and its aftermath. *Ancient Mesoamerica*, *14*(01), pp.151-156.

Angel, J.L., 1966. 'Porotic Hyperostposis, anemias, malarias, and marches in the prehistoric eastern Mediterranean,' Science 153: 760-762.

Appadurai, A., 1986. Theory in anthropology: center and periphery. *Comparative Studies in Society and History*, *28*(02), pp.356-374.

Argo, L.J., 2010. *Exploring Classic Maya Sociopolitical Organization of Middle Level Settlements: A Ceramic Perspective of Say Kah, Belize*. Doctoral dissertation, University of Cincinnati, Cincinnati Ohio

Armstrong, C. 1989. *Pathological Analysis of Long Bones within the Tipu Population*. Masters Thesis, State University of New York at Plattsburgh, Plattsburg

Alesbury, H.S., Ubelaker, D.H. and Bernstein, R., 2013. Utility of the frontonasal suture for estimating age at death in human skeletal remains. *Journal of forensic sciences*, *58*(1), pp.104-108.

Alvar, J., Velez, I.D., Bern, C., Herrero, M., Desjeux, P., Cano, J., Jannin, J., den Boer, M. and WHO Leishmaniasis Control Team, 2012. Leishmaniasis worldwide and global estimates of its incidence. *PloS one*, *7*(5), pp. 35671.

Armelagos, G.J., 1998. 'Introduction: sex, gender and health status in prehistoric and contemporary populations.' *Sex and gender in paleopathological perspective*, pp.1-10.

Ashmore, Wendy, 1991. 'Site-Planning Principles and Concepts of Directionality among the Ancient Maya' L*atin American Antiquity* Vol. 2, No. 3 pp. 199-226

--- 2013 'Mobile Bodies, Empty Spaces' *The Dead Do Tell Tales: essays in honor of Jane E. Buikstra.* The Cotsen Institute of Archaeology Press, University of California, Los Angeles.

Ashmore, Wendy and Jeremy A. Sabloff, 2002. 'Spatial Orders in Maya Civic Plans,' *Latin American Antiquity* Vol. 13, No. 2 pp. 201-215

Asiedu, K., Amouzou, B., Dhariwal, A., Karam, M., Lobo, D., Patnaik, S. and Meheus, A., 2008. Yaws eradication: past efforts and future perspectives. *Bulletin of the World Health Organization*, *86*(7), pp.499A-499A.

Atran, Scott, 1999. 'Managing the Maya Commons: The Value of Local Knowledge.' *Ethoecology: Situated Knowledge/located Lives* Ed. Virginia D. Zazarea University of Arizon Press, Tucson pp. 190-214.

Aufderheide, Arthur C. and Conrado Rodriguez-Martin 1998. *The Cambridge Encyclopedia of Human Paleopathology.* Cambridge University Press, New York

Baig, S., Patil, N. and Considine, N., 2012. 'An unusual cause of recurrent throat pain-calcified stylohyoid ligament.' *Journal of the College of Physicians and Surgeons Pakistan*, *22*(4), pp.258-260.

Baker, Robert E., 1996. 'Status Report on the Settlement Survey.' *Archaeological Research at Blue Creek Belize, Progress Report of the Fourth (1995) Field Season*. Ed. Thomas H. Guderjan, W. David Driver, and Helen R. Haines pp. 109-116

Balcioglu HA, Kilic C, Akyol M, Ozan H, Kokten G. Length of the styloidprocess and anatomical implications for Eagle's syndrome. *Folia Morphol (Warsz)*. Nov 2009. 68:265-70

Barrett, Jason W., 2003. 'Restricted Entitlement and Resistance Strategies: Ancient Maya Resource Control and Resistance Strategies,' *Blue Creek Regional Political Ecology Project: 2001 and 2002 Research Summaries*. Ed. John C. Lohse, Submitted to The Institute of Archaeology, Government of Belize, Belmopan, pp. 20-34

---2004. Constructing Hierarchy Through Entitlement: Inequality in Lithic Recourse Access Among the Ancient Maya of Blue Creek, Belize. PhD dissertation, Texas A&M University, College Station Texas

---2011. 'Continuing Excavations at Courtyard 5E and Nojol Nah,' *The 19th annual report of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan pp. 37-62

Barrett, Jason W., and William T. Brown, 2009. 'Excavations at Nojol Nah.' *Seventieth Sojourn: The 2008 Season of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology, National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan, Jason Barrett, and Tim Preston pp. 59-92

Barrett, Jason, Bruce Dickson, and William T. Brown, 2011. 'Developing a Sense of Place at Nojol Nah,' *The 19th annual report of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan pp 27-36

Barrett, Jason and Tara Majewski, 2010. 'Excavations at the Group 5A Plazuela: An Elite Residential group at Nojol Nah,' *The 2009 Season of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan pp. 59-76.

Bass, William M. 1984 *Human Osteology: A Laboratory and Field Manual.* Missouri Archaeological Society, Columbia USA.

Beach, Tim 1998. Soil constraints on Northwest Yucatan, Mexico: pedoarchaeology and Maya subsistence at Chunchucmil. *Geoarchaeology*,*13*(8), pp.759-791.

Beach, Tim, S Luzzadder-Beach, N. Dunning, J. Jones, J. Lohse, T. Guderjan, S. Bozarth, S. Millspaugh, and T. Bhattacharya. 2009. A Review of Human and Natural Changes in Maya Lowlands Wetlands over the Holocene. *Quaternary Science Reviews*. Vol. 28:1710-1724.

Beach, Tim; Sheryl Luzzadder-Beach; Thomas Guderjan, Samantha Krause 2014. 'The floating gardens of Chan Cahal: Soils, water, and human interactions.' Elseiver, *In Press*

Berryman, H.E. and Haun, S.J., 1996. 'Applying forensic techniques to interpret cranial fracture patterns in an archaeological specimen.' *International Journal of Osteoarchaeology*, *6*(1), pp.2-9.

Binford, Louis R. 1962. 'Archaeology as Anthropology' *American Antiquity*. Vol 28 No. 2 Society for American Archaeology pp. 217-225

Black, S. and Scheuer, L., 1996. 'Age changes in the clavicle: from the early neonatal period to skeletal maturity.' *International Journal of Osteoarchaeology*, *6*(5), pp.425-434.

Bleuze, Micheal, 2011. 'Health Status and Long Bone Lengths Among Maya Sub-adults from Two Coastal Sites in Belize.' *Totem: The University of Western Ontario Journal of Anthropology*. Vol. 15 Issue 1 pp. 66-79

Blom, D.E., Buikstra, J.E., Keng, L., Tomczak, P.D., Shoreman, E. and Stevens-Tuttle, D., 2005. 'Anemia and childhood mortality: Latitudinal patterning along the coast of pre-Columbian Peru.' *American Journal of Physical Anthropology*, *127*(2), pp.152-169.

Boyd, Donna C., 1996, 'Skeletal Correlates of Human Behavior in the Americas,' *Journal of Archaeological Method and Theory*, Vol. 3 No. 3 pp. 189-251

Boyd, C.C. and Boyd, D.C., 1997. 'Osteological comparison of prehistoric Native Americans from southwest Virginia and east Tennessee mortuary caves.' *Journal of Caves and Karst Studies*, *59*, pp.160-165.

Bridges, Patricia S. 1992. 'Prehistoric Arthritis in the Americas,' *Annual Review of Anthropology,* Vol. 21 pp. 67-91

Brinkley, Megan and Rachel Ives. 2008, *The Bioarchaeology of Metabolic Bone Disease*. Academic Press, Elsevier Ltd. London England

Brooks, S. and Suchey, J.M., 1990. 'Skeletal age determination based on the os pubis: a comparison of the Acsádi-Nemeskéri and Suchey-Brooks methods,' *Human evolution*, *5*(3), pp.227-238.

Brown, Terry and Keri Brown, 2011. *Biomolecular Archaeology An Introduction*, Wiley-Blackwell West Sussex, UK

Brown, William T., 2009. 'Preliminary osteological analysis of burials from Nojol Nah Operation 3,' *Seventieth Sojourn: The 2008 Season of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology, National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan, Jason Barrett, and Tim Preston pp. 103-148

---2010. 'Fieldwork at Nojol Nah, Operation 3/Casa de los Muertos,' *The 2009 Season of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan pp. 77-106

---2011. 'The Toucan House Courtyard: Archaeological Investigation of a Late and Terminal Classic Elite Maya Residence, Northwestern Belize,' *The 19th annual report of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan pp. 63-110

---2013. ‘Preliminary Excavations at El Palacio: Report of the First Season of Archaeological Investigation of a Multi-Component Elite Maya Residence, Northwestern Belize,’ Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 33-141

Brown, William T. and Hannah Plumer, 2012. ‘Osteological Analysis of Skeletal Remains Recovered from Multiple Prehistoric Maya Settlements During 2011,’ *The 20th annual report of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize, Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 129-194

---2013. ‘Bioarchaeological Analysis of Maya Remains from Kin Tan and those Recovered from Nojol Nah during the 2012 Season,’ *The 21st annual report of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 227-366

---2014. ‘Report on the First Maya Research Program Bioarchaeological Field School: Osteological Analysis of Eight Maya Burials from Xnoha,’ *The 22nf annual report of the Blue Creek Archaeological Project.* Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 413-440

Brown, William T., Carlos Quiroz and Hannah Plumer, 2014. ‘Continuing Excavations at El Palacio: Report of the Second Season of Archaeological Investigation of a Multi-Component Elite Maya Residence,’ *The 22nf annual report of the Blue Creek Archaeological Project.* Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 191-412

Brown, William T., and Dawn Strohmeyer, 2011. ‘Life and Death at Nojol Nah: Analysis of the 2010 Assemblage and Synthesis of Three Years of Bioarchaeological Inquiry,’ *The 19th annual report of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan pp. 111-198

Brown, William T., Dawn Strohmeyer, and Jason Barrett, 2010. ‘Osteological Analyses of 24 burial from two Late Classic Residences at Nojol Nah, excavated in 2008 and 2009,’ *The 2009 Season of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan pp. 107-174

Buckberry, J.L. and A.T. Chamberlain, 2002. ‘Age Estimation From the Auricular Surface of the Ilium: A Revised Method.’ *American Journal of Physical Anthropology* Vol. 119 pp. 231-239

Buikstra, Jane E., 1997. ‘Studying Maya Bioarchaeology,’ *Bones of the Maya*. Ed. Stephen L. Whittington and David M. Reed pp. 221-228. Washington, D.C.: Smithsonian Institute Press.

Buikstra, Jane E., and Douglas H. Ubelaker, 1994, ‘Standards for Data Collection from Human Skeletal Remains: Proceedings of a Seminar at the Field Museum of Natural History Organized by Jonathan Haas,’ *Arkansas Archaeological Survey Research Series* No. 44

Bullard Jr, W.R., 1960. Maya settlement pattern in northeastern Peten, Guatemala. *American Antiquity*, pp.355-372.

Bullock, Meggan, Lourdes Marquez, Patricia Hernandez, and Fernando Ruiz, 2013. ‘Paleodemographic Age-at-Death Distributions of Two Mexican Skeletal Collections: A Comparison of Transition *Analysis and Traditional Aging Methods.’* American Journal of Physical Anthropology. 152: 67-78

Burnett, Scott E, Joel D. Irish and Michael R. Frong, 2013 ‘Wear’s the problem? Examining the effect of dental wear on studies of crown morphology.’ *Anthropological Perspectives on Tooth Morphology: Genetics, Evolutions, Variation*, ed. G. Richard Scott and Joel D. Irish. Cambridge University Press 535-554.

Bush, H., 1991. ‘Concepts of health and stress.’ *Health in Past Societies: Biocultural Interpretations of Human Skeletal Remains in Archaeological Contexts, BAR International Series*, *567*, pp.11-21.

Bush, H. and Zvelebil, M., 1991. ‘Pathology and health in past societies: an introduction.’ *Health in past societies: biocultural interpretations of human skeletal remains in archaeological context*, pp.3-9.

Campbell, L., Kaufman, T. and Smith-Stark, T.C., 1986. ‘Meso-America as a linguistic area.’ *Language*, pp.530-570.

Cardoso, H.F.V. 2008. ‘Epiphyseal fusion at the innominate and lower limb in a modern Portugese skeletal sample, and age estimation in adolescent and young adult male and female skeletons.’ *American Journal of Physical Anthropology* 135: 161-170.

Chamberlian, Andrew 2006. *Demography in Archaeology*. Cambridge Manuals in Archaeology, Cambridge University Press, Cambridge, England.

Chase, D.Z., 1994. ‘Human Osteology, Pathology, and Demography as: Represented in the Burials of Caracol, Belize.’ Ed. D. Chase and A. Chase, *Studies in the Archaeology of Caracol, Belize* pp. 123-138, Pre-Columbian Art Research Institute Monograph 7, San Francisco

Chase, Arlen, F. and Diane Z. Chase 2001. 'Ancient Maya Causeways and Site Organization at Caracol, Belize.' *Ancient Mesoamerica*, 12, Cambridge University Press, 273-281

---2004. 'Exploring Ancient Economic Relationships at Caracol, Belize,' *Research Reports in Belizean Archaeology*, 1, pp. 115-127

Chase, Diane Z. and Arlen F. Chase, 1996. 'Maya Multiples: Individuals, Entries, and Tombs in Structure A34 of Caracol, Belize.' *Latin American Antiquity* 7(1): pp. 61-79

-- 1998. The architectural context of caches, burials, and other ritual activities for the Classic period Maya (as reflected at Caracol, Belize). *Function and meaning in Classic Maya architecture*, pp.299-332.

Cheetham, D., 2010. 'Corn, Colanders, and Cooking: Early Maize Processing in the Maya Lowlands and Its Implications.' In *Pre-Columbian Foodways* (pp. 345-368). Springer New York.

Christenson, Allen J. 2007. *The Popol Vuh: Sacred Book of the Maya*. University of Oklahoma Press.

Clagett, Heather L., 1997. 'Household Archaeology at Chan Cahal: a step beyond functionalism,' *The Blue Creek Project: Working Papers from the 1996 Field Season,* Ed. W. David Driver, Heather L. Clagett, and Helen R. Haines pp. 61-70

Clayton, Sarah C., 2003. 'Summary of Fieldwork at the Rio Hondo House Mound Hinterland Settlement, Blue Creek Belize 2002,' *Blue Creek Regional Political Ecology Project: 2001 and 2002 Research Summaries*. Ed. John C. Lohse, Submitted to The Institute of Archaeology, Government of Belize, Belmopan, pp. 25-38

Coale, A.J., Demeny, P., and Vaughan, B., 1983. 'Models of mortality and age composition.'*Regional model life tables and stable population. 2nd ed*. New York: Academic Press, 193, pp.3-7.

Coe, Michael D., 2005. *The Maya*, Seventh Edition, Thames and Hudson New York New York

Cohen, Mark N., Kathleen O'Conner, Marie Elaine Danforth, Keith P. Jacobi, and Carl Armstrong, 1997. 'Archaeology and Osteology of the Tipu Site,' *Bones of the Maya*. Editors Whittington and Reed. University of Alabama Press, Tuscaloosa Alabama. pp: 78-88

Corruccini, Robert S., Jerome S. Handler, Robert J. Mutaw and Frederick W. Lange, 1982. 'Osteology of a Slave Burial Population From Barbados, West Indies,' *American Journal of Physical Anthropology,* Vol. 59 pp443-459

Couoh, L.R., 2013. ‘Bioarchaeological Analysis of a Royal Burial from the Oldest Maya Tomb in Palenque, Mexico.’ *International Journal of Osteoarchaeology.*

Cowgill, George, 1996. ‘A Reconsideration of the Postclassic Chronology of Central Mexico.’ Ancient Mesoamerica 7:325-331

Craig, E.F., 2009. *Burial practices in Northern England c AD 650-850: A bio-cultural approach* (Doctoral dissertation, The University of Sheffield).

Crowder, Christian and Sam Stout, 2012. *Bone Histology: An Anthropological Perspective.* CRC Press Taylor and Francis Group, Boca Raton, FL

Cruz, A.R., 1996. *The two milpas of Chan Kom: scenarios of a Maya village life*. SUNY Press.

Cucina, Andrea, 2011, ‘Maya Sub Adult Mortality and Individual Physiological Frailty: An Analysis of Infant Stress by Means of Linear Enamel Hypoplasia,’ *Childhood In the Past* Vol. 4 pp. 105-116

Cucina, Andrea and Vera Tiesler, 2003. ‘Dental Caries and Antemortem Tooth Loss in the Northern Petén Area, Mexico: A Biological Perspective on Social Status Difference Among the Classic Maya,’ *American Journal of Physical Anthropology* Vol. 122 1-10

--- 2005, ‘Past, present and future itineraries in Maya bioarchaeology,’ *Journal of Anthropological Sciences,* Vol. 83 pp. 29-42

---2006. ‘The companions of Janaab’Pakal and the “Red Queen” from Palenque, Chiapas: Meanings of human companion sacrifice in Classic Maya society.’ *Janaab’Pakal of Palenque. Reconstructing the Life and Death of a Maya Ruler*, pp.102-125.

Cucina, Andrea, Vera Tiesler Blos and Thelma Sierra Sosa, 2003. ‘Sex Differences in Oral Pathologies at the Late Classic Maya Site of Xcambo, Yucatan,’ *Dental Anthropology,* Vol. 16 No. 2 pp. 45-51

Currid, Demori, 2002. ‘Excavations in the Structure 60 Courtyard.’ *Working Papers of the Blue Creek Project 1998 & 1999 Field Seasons,* Ed. Thomas Guderjan. pp. 95-100

Cybulski, Jerome S. 1988 ‘Skeletons in the Walls of Old Quebec,’ Northeast Historical Archaeology, Vol. 17, Issue 1 Article 4 pp.61-84

Danforth, Marie Elaine, Keith P. Jacobi and Mark Nathen Cohen, 1997, ‘Gender and Health Among the Colonial Maya of Tipu, Belize.’ *Ancient Mesoamerica*, Vol. 8 No. 1 pp. 13-22

Danforth, Marie Elaine, Gabriel D. Wrobel, Carl W. Armstrong, and David Swanson, 2009, 'Juvenile Age Estimation Using Diaphyseal Long Bone Length Among Ancient Maya Population,' *Latin American Antiquity,* Vol. 20 No. 1 pp. 3-13

Dar Gali, Youssef Masharawi, Smadar Peleg, Nili Stienberg, Hila May, Bahaa Medlej, Natan Peled, Isreal Hershkovitz, 2010. 'Schmorl's nodes distribution in the human spine and its possible etiology'. Eur Spine J 19 (670-675)

Das Neves, Virginia A., 2012. 'Childhood origin and diet of the ancient Maya: a pilot study of strontium, oxygen and carbon isotope analyses on human tooth enamel from Njol Nah, Orange Walk District,' *The 20th annual report of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize, Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 195-243

Degusta, D., 2010. 'Cribra Orbitalia: A Non-human Primate Perspective.' *International Journal of Osteoarchaeology*. Vol. 20. pp. 597-6-02. John Wiley & Sons, Ltd.

Deschenes, Brie and Carlos Quiroz, 2015. 'Excavation of Structure 1, Xnoha,' *The 23rd annual report of the Blue Creek Archaeological Project.* Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. C. Colleen Hanratty and Thomas H. Guderjan pp. 127-136

Dewitte, Sharon N. and Christopher M Stojanowski 2015. 'The Osteological Paradox 20 Years Later: Past Perspectives, Future Directions.' *Journal of Archaeological Resources* Vol. 23 pp. 397-450

Dickson, Bruce, 2009. 'Excavations at Nojol Nah Structure 1.' *Seventieth Sojourn: The 2008 Season of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology, National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan, Jason Barrett, and Tim Preston pp. 93-102

Dobney, K. and Goodman, A., 1991. 'Epidemiological studies of dental enamel hypoplasias in Mexico and Bradford: their relevance to archaeological skeletal studies.' *Health in Past Societies. Biocultural Interpretations of Human Skeletal Remains in Archaeological Contexts. BAR International Series*, *567*.

Domett, K.M., and H.R. Buckley, 2012. 'Large Lytic Cranial Lesions: A Differential Diagnosis from Pre-Angkorian Cambodia,' *International Journal of Osteoarchaeology,* Vol. 22 pp. 731-739

Driver, David W., 1996. 'Continuing Excavations at Structure 1' *Archaeological Research at Blue Creek Belize, Progress Report of the Fourth (1995) Field Season*. Ed. Thomas H. Guderjan, W. David Driver, and Helen R. Haines pp. 27-36

---1997. 'The Third Season of Excavations at Structure 1,' *The Blue Creek Project: Working Papers from the 1996 Field Season,* Ed. W. David Driver, Heather . Clagett, and Helen R. Haines pp. 29-32

---1999. 'Excavations in Plaza A,' *The Blue Creek Project: Working Papers from the 1997 Season*. Ed. W. David Driver, Helen R. Haines and Thomas H. Guderjan pp. 12-38

---2001. 'The Completion of Excavations in the Site Core: Structures 13, 15, 21, and 24.' Blue Creek Archaeological Project: *Working Papers from the 2000 Field Season*. Ed. Thomas H. Guderjan and Robert J. Lichtenstein

---2004. 'Inter-Community Architectural Variation: Excavations Conducted in the Blue Creek Settlement Zone,' *Blue Creek Regional Political Ecology Project: 2003 Research Summary*. Ed. John C. Lohse, Submitted to The Institute of Archaeology, Government of Belize, Belmopan, pp. 53 -80

---2008. *The Construction of Intrapolity Sociopolitical Identity Through Architecture at the Ancient Maya Site of Blue Creek, Belize.* PhD Dissertation, Southern Illinois University, Carbondale, Illinois

Driver, David W., Elizabeth Boyd, and Stephen Pilcher, 2002. 'Excavations in the Core Zone.' Working Papers of the Blue Creek Project 1998 & 1999 Field Seasons,' Ed. Thomas Guderjan. pp. 49-58

Duncan, William 2009. 'Cranial Modification Among the Maya: Absence of Evidence or Evidence of Absence?' *Bioarchaeology and Identity in the Americas,* ed. Kelly J. Knudson and Christopher M. Stojanowski pp. 177-193

Duncun, William N. and Jon B. Hageman, 2015. 'House or Lineage? How Intracemetery Kinship Analysis Contributes to the Debate in the Maya Area.' *Archaeology and Bioarchaeology of Population Movement among the Prehispanic Maya,* ed. Andrea Cucina, Springer

Duncan, William N. Charles Andrew Hofling 2011. 'Why the Head? Cranial Modification as Protection and Ensoulment Among the Maya,' *Ancient Mesoamerica*, 22 199-210

Dunning, Nicholas P., Timothy P. Beach, and Sheryl Luzzadder Beach, 2009 Creating a stable landscape: soil conservation among the ancient Maya. Chapter 4 in: *The Archaeology of Environmental Change: Socionatural Legacies of Degradation and Resilience*. Chris. T. Fisher, J. Brett Hill, and Gary M. Feinman (eds.), University of Arizona Press, Tucson AZ, pp. 85-105.

---2012. 'Kax and Kol: Collapse and resilience in lowland Maya civilization,' *Proceedings of the National Academy of Sciences in the United States of America (PNAS)* Vol 109 pp. 3652-3657

Dunning, N.P., Luzzadder-Beach, S., Beach, T., Jones, J.G., Scarborough, V. and Culbert, T.P., 2002. ‘Arising from the bajos: The evolution of a neotropical landscape and the rise of Maya civilization.’ *Annals of the Association of American Geographers*, *92*(2), pp.267-283.

Dutour, O., Ardagna, Y., Maczel, M. and Signoli, M. 2003. ‘Epidemiology of infectious diseases in the past.’ *Emerging Pathogens: the Archaeology, Ecology and Evolution of Infectious Disease*. Ed. Greenblatt, C. and Spigelman, M Oxford: Oxford University Press, pp. 151-165.

Eberl, Markus and Christian Prager, 2005. ‘B'olon Yokte'K'uh Maya conceptions of war, conflict, and the underworld.’ *BAR INTERNATIONAL SERIES*, *1385*, p.28.

Edmonson, Munro S. 2010 *The ancient future of the Itza: The book of Chilam Balam of Tizimin*. University of Texas Press, Austin Texas.

Ek, Jerry, 2001. ‘Continuing Excavations at the Structure 37 Plazuela,’ Blue Creek Archaeological Project: *Working Papers from the 2000 Field Season*. Ed. Thomas H. Guderjan and Robert J. Lichtenstein

---2002. ‘Excavations in the Structure 46 Courtyard’ *Working Papers of the Blue Creek Project 1998 & 1999 Field Seasons,* Ed. Thomas Guderjan. pp. 85-94

El-Najjar, M.Y., Ryan, D.J., Turner, C.G. and Lozoff, B., 1976. ‘The etiology of porotic hyperostosis among the prehistoric and historic Anasazi Indians of southwestern United States.’ *American Journal of Physical Anthropology*, *44*(3), pp.477-487.

Elson, Christina M., and Kenneth Mowbray, 2005. ‘Burial Practices at Teotihuacan in the Early Postclassic Period: the Vaillant and Linne Excavations (1931-1932),’ *Ancient Mesoamerica* Vol. 16: 2 pp. 195-211

Evans, Susan Toby, 2008. *Ancient Mexico and Central America: Archaeology and Culture History*. Thames and Hudson New York NY

Ewald, P.W., 2003. ‘Evolution and ancient diseases: The roles of genes, germs, and transmission modes.’ *Emerging pathogens: Archaeology, ecology and evolution of infectious disease*, pp.117-124.

Facchini, F., E. Rastelli and P. Brasili, 2004. ‘Cribra orbitalia and cribra cranii in Roman Skeletal Remains from the Ravenna Area and Rimini (I-IV Century AD),’ *International Journal of Osteoarchaeology,* Vol. 14 pp. 126-136

Fairgrieve, Scott I., and J.E. Molto, 2000. ‘Cribra Orbitalia in Two Temporally Disjunct Population Samples in the Dakhleh Oasis, Egypt,’ *American Journal of Physical Anthropology,* Vol. 111 pp. 319-331

Farr, Olivia, 2002. ‘Excavations at Structure 78.’ *Working Papers of the Blue Creek Project 1998 & 1999 Field Seasons,* Ed. Thomas Guderjan. pp. 65-68

Fash, William L. 1994. ‘Changing Perspectives on Maya Civilization,’ *Annual Review of Anthropology*, Vol. 23, pp. 181-208

Field, Andy 2013. *Discovering Statistics using IBM SPSS Statistics*, 4th Edition Sage Publications Ltd. London UK.

Finnegan, Michael, 1978. ‘Non-metric variation of the infracranial skeleton.’ *Journal of Anatomy* Vol. 125 pp. 23-37

Fitzsimmons, James L, 2009. *Death and the Classic Maya Kings*. University of Texas Press at Austin, TX

Fitzsimmons, James L., Andrew Scherer, Stephen D. Houston and Hector L. Escobedo, 2003. ‘Guardian of the Acropolis: The Sacred Space of a Royal Burial at Piedras Negras, Guatemala,’ *Latin American Antiquity,* Vol. 14 No. 4 pp. 449-468

Flannery, Kent V. 1967. ‘Vertebrate fauna and hunting patters,’ *The Prehistory of the Tehuacan Valley, Vol. 1*. Ed D.S Byers, University of Texas Press, Austin Texas pp. 132-177.

---1976. *The Early Mesoamerican Village.* Academic Press, New York

Flohr, Stefan and Micheal Schultz, 2009. “Mastoiditis – Paleopathological Evidence of a Rarely Reported Disease.” *American Journal of Physical Anthropology* 138: 266-273.

Franklin, Daniel 2010, ‘Forensic age estimation in human skeletal remains: Current concepts and future directions’, *Legal Medicine* 12 (2010) 1-7

Garn, S.M., 1992. ‘The iron-deficiency anemias and their skeletal manifestations.’ *Diet, Demography and Disease: Changing Perspectives on Anemia. New York: Aldine*, pp.33-63.

Geller, Pamela L. 2005, ‘Skeletal Analysis and Theoretical Complications.’ *World Archaeology* vol. 37. No. 4 pp. 597-609

--- 2006. “Altering Identities: body modifications and the pre-Columbian Maya,” *Social Archaeology of Funerary Remains,* ed. Rebecca Gowland and Christopher Knusel. Oxbow Books, Alden Press, Oxford, UK pp. 279-291

---2011. ‘Getting a Head Start in Life: Precolumbian Maya Cranial Modification from Infancy to Ancestorhood.’ In *The Bioarchaeology of the Human Head:*

Decapitation, Decoration, and Deformation. Ed. Michelle Bonogofsky, The University Press of Florida pp. 241-261

---2012a 'The Sacrifices We Make of and for Our Children: Making sense of Pre-Columbian Maya practices,' In *Breathing New Life into the Evidence of Death* ed. Aubrey Baadsguard, Alexis T. Boutin and Jane E. Buikstra 79-108

---2012b. 'Parting [with] the Dead: Body Partibility as Evidence of Commoner Ancestor Veneration.' Ancient Mesoamerica 23, 115-130 Cambridge University Press 2012

---2012c. 'From Cradle to Grave and Beyond: A Maya Life and Death,' *The Bioarchaeology of Individuals*. Ed. Ann L.W. Stodder and Ann M. Palkovich pp. 255-270

Giacometti, A. and D. Lalonde 2001. 'Continuing Excavations at the Structure 46 Courtyard,' Blue Creek Archaeological Project: *Working Papers from the 2000 Field Season*. Ed. Thomas H. Guderjan and Robert J. Lichtenstein

Gifford, D.P., 1981. Taphonomy and paleoecology: a critical review of archaeology's sister disciplines. *Advances in archaeological method and theory*, *4*, pp.365-438.

Gilgan, Elizabeth, 1996. 'Excavations at Structure 13 Courtyard Complex.' *Archaeological Research at Blue Creek Belize, Progress Report of the Fourth (1995) Field Season*. Ed. Thomas H. Guderjan, W. David Driver, and Helen R. Haines pp. 69-77

---1997. 'Excavations in the Structure 13 Courtyard Group,' *The Blue Creek Project: Working Papers from the 1996 Field Season,* Ed. W. David Driver, Heather . Clagett, and Helen R. Haines pp. 33-38

Gillespie, Susan, 2001. 'Personhood, Agency, and Mortuary Ritual: A Case Study from the Ancient Maya.' *Journal of Anthropological Archaeology,* 20 pp. 73-112
Gillespie, Susan, 2000. 'Rethinking Maya Social Organization: Replacing 'Lineage' with 'House',' *American Anthropologist*, New Series, Vol. 102, No. 3 (Sep., 2000), pp. 467-484

Gilmore, Cassandra C., and Mark N. Grote, 2012 'Estimating Age from Adult Occlusal Wear: A Modification of the Miles Method,' *American Journal of Physical Anthropology* 149:181-192

Goldberg, H.J., Weintraub, J.A., Roghmann, K.J. and Cornwell, W.S., 1976. 'Measuring periodontal disease in ancient populations: root and wear indices in study of American Indian skulls.' *Journal of periodontology*, *47*(6), pp.348-351.

Gómara Gallegos, M.J., 2003. Mujeres y hombres de barro: Figurillas de Comalcalco. *Arqueología Mexicana*, *11*(61), pp.48-51.

Gonzalez, Jason J., 2003. 'Cultural Landscapes, Cultural Identity: Settlement at Ixno 'Ha, Belize,' *Blue Creek Regional Political Ecology Project: 2001 and 2002 Research Summaries*. Ed. John C. Lohse, Submitted to The Institute of Archaeology, Government of Belize, Belmopan, pp. 39-43

---2004. 'Ixno 'Ha Excavation Report 2003.' *Blue Creek Regional Political Ecology Project: 2003 Research Summary*. Ed. John C. Lohse, Submitted to The Institute of Archaeology, Government of Belize, Belmopan, pp. 33-52

---2005. '2004 Ixno 'Ha Excavation Report,' *2004 Season Summaries of the Blue Creek Regional Political Ecology Project, Upper Northwestern Belize*. Submitted to the Institute of Archaeology, National Institute of Culture and History, Belmopan, Belize

---2006. '2005 Season of the Blue Creek Regional Ecology Project: Project Overview,' *Final Season Summaries of the Blue Creek Regional Political Ecology Project: 2005 Investigations in Upper Northwestern Belize.* Ed. Jon C. Lohse, Report Submitted to the Institute of Archaeology, National Institute of Culture and History, Belmopan, Belize, pp. 1-11

Goodman, Allen H. 1993. 'On the Interpretation of Health from Skeletal Remains.' *Current Anthropology* 34(3) pp. 281-288

Goodman, Allen H. and Debra L. Martin 2002. 'Reconstructing Health Profiles form Skeletal Remains.' *The Backbone of History: Health and Nutrition in the Western Hemisphere*. Ed. Richard H. Steckel and Jerome C. Rose. Cambridge University Press New York NY pp. 11-60

Goodman, Allen H., and Rhan-Ju Song 1999. 'Sources of Variation in Estimated ages at Formation of Linear Enamel Hypoplasias,' *Human Growth in the Past: Studies from Bones and Teeth*, Eds. Robert D. Hoppa and Charles M. Fitzgerald Cambrige University Press, pp. 210-240

Goodman, Alan H., Debra L Martin, George J. Armelagos and George Clark, 1984. 'Indications of Stress from Bone and Teeth.' *Paleopathology at the Origins of Agriculture,* Ed. Nathan Cohen and George J. Armelagos, Ed. Academic Press, Inc. New York. pp. 13-49.

Goodrich, James Tait and Fernando Chico Ponce de Leon, 2010. 'Medical and Surgical Practice As Represented in Cultural Figures from the Pre-Conquest Mesoamerican Territories.' *World Neurosurgery*, 74 (1) 81-96 July 2010

Graham, Elizabeth, 2004 'Lamanai Reloaded: Alive and Well in the Early Postclassic.' In *Archaeological Investigations in the Eastern Maya*

Lowlands: Papers of the 2003 Belize Archaeology Symposium Research Papers in Belizean

---2011 *Maya Christians and Their Churches in Sixteenth-Century Belize*. University Press Florida, Gainesville, Florida

Graham, E., Pendergast D.M., and Jones, G.D., 1989 'On the fringes of conquest: Maya-Spanish contact in colonial Belize. *Science* 246:1254-1259

Greaves, Pieta, 2015. 'Wall Painting conservation at Tulix Mul,' *The 23rd annual report of the Blue Creek Archaeological Project.* Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. C. Colleen Hanratty and Thomas H. Guderjan pp. 161-172

Greaves, Pieta and Thomas Guderjan, 2012. 'Excavations at Bedrock 2011,' *The 20th annual report of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize, Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 29-40

Greaves, Pieta, Thomas Guderjan, and William T. Brown, 2009. *Seventieth Sojourn: The 2008 Season of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology, National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan, Jason Barrett, and Tim Preston pp. 47-58

Grauer, Allison L., 2008. 'Macroscopic Analysis and Data Collection in Paleopathology,' *Advances in Human Paleopathology*, Ed. Ron Pinhasi and Simon Mays pp. 57-76

Grimoud, A.M., Lucas, S., Sevin, A., Georges, P., Passarrius, O. and Duranthon, F., 2011. Frequency of dental caries in four historical populations from the Chalcolithic to the Middle Ages. *International journal of dentistry*,*2011*.

Grube, N. 2000. *A comparative study of thirty city-state cultures: an investigation* (Vol. 21). Edited by Hansen, M.H. Kgl. Danske Videnskabernes Selskab.

Guderjan, Thomas, H. 1996a. 'Introduction to the 1995 Field Season,' *Archaeological Research at Blue Creek Belize, Progress Report of the Fourth (1995) Field Season*. Ed. Thomas H. Guderjan, W. David Driver, and Helen R. Haines pp. 1-4

---1996b. 'Summary of the Research at Blue Creek,' *Archaeological Research at Blue Creek Belize, Progress Report of the Fourth (1995) Field Season*. Ed. Thomas H. Guderjan, W. David Driver, and Helen R. Haines pp. 5-26

---1996c. ‘Kakabish: Mapping of a Maya Center,’ *Archaeological Research at Blue Creek Belize, Progress Report of the Fourth (1995) Field Season*. Ed. Thomas H. Guderjan, W. David Driver, and Helen R. Haines pp. 117-120

---2002. ‘A Summary of Research at Blue Creek,’ *Working Papers of the Blue Creek Project 1998 & 1999 Field Seasons,* Ed. Thomas Guderjan. pp. 3-36

--- 2007a. *The Nature of an Ancient Maya City: Resources, Interaction, and Power at Blue Creek, Belize*. University of Alabama Press. Tuscaloosa, Alabama.

---2007b. A Framework for modeling Maya cities and their Political Economies: Integrating the Residential Components to the Core Area. *Blue Creek Archaeological Project: Report of the 2006 Fieldwork*. Submitted to the Institute of Archaeology, National Institute of Culture and History, Belmopan, Belize pp. 3-11

---2007c. Additional operations in 2006. *Blue Creek Archaeological Project: Report of the 2006 Fieldwork*. Submitted to the Institute of Archaeology, National Institute of Culture and History, Belmopan, Belize pp. 80-87

--- 2009a. “Power and Authority in and Ancient Maya City” *Research Reports on Belizean Archaeology: Papers of the 2008 Belize Archaeology Symposium* pages 119-136 Editors John Morris, Sherilyne Jones, Jaime Awe, George Thompson, and Christophe Helmke

---2009. Project Background: A Summary of Research at Blue Creek. *Seventieth Sojourn: The 2008 Season of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology, National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan, Jason Barrett, and Tim Preston pp. 3-14

---2013a. ‘Introduction,’ *The 21st annual report of the Blue Creek Archaeological Project* Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 1-22

---2013b. ‘Executive Summary,’ *The 21st annual report of the Blue Creek Archaeological Project* Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 391-394

---2014a. ‘Introduction,’ *The 22nd annual report of the Blue Creek Archaeological Project.* Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 1-16

---2014b. ‘Executive Summary,’ *The 22nd annual report of the Blue Creek Archaeological Project.* Submitted to the Institute of Archaeology National

Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 503-504

---2014c. 'Mortuary Ritual in the Terminal Preclassic: Evidence from the Maya Site of Blue Creek in Northern Belize." Submitted to Research in Belizean Archaeology Feb 2014

---2015a. Blue Creek Archaeological Project: Proposal for 2015 fieldwork. Submitted to the *Institute of Archaeology National Institute of Culture and History,* Belmopan Belize*. Maya Research Program* and *Centre for Social Sciences Research University of Texas at Tyler* March 2015

---2015b. 'Introduction,' *The 23rd annual report of the Blue Creek Archaeological Project.* Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. C. Colleen Hanratty and Thomas H. Guderjan pp. 1-16

---2015c. 'Executive Summary,' *The 23rd annual report of the Blue Creek Archaeological Project.* Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. C. Colleen Hanratty and Thomas H. Guderjan pp. 231-235

Guderjan, Thomas H., Timothy Beach and Sheryl Luzzadder-Beach, 2009. 'Understanding the Causes of Abandonment in the Maya Lowlands,' *Seventieth Sojourn: The 2008 Season of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology, National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan, Jason Barrett, and Tim Preston pp. 15-22

Guderjan, Thomas H., and W. David Driver, 1999. 'Architecture and Ritual at Blue Creek,' *The Blue Creek Project: Working Papers from the 1997 Season*. Ed. W. David Driver, Helen R. Haines and Thomas H. Guderjan pp. 1-11

Guderjan, Thomas H., and Samantha Krause 2011. 'Identifying the Extent of Ancient Maya Ditched Field Systems in the Rio Hondo Valley – A Pilot Study,' *The 19th annual report of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan pp. 217-228

Guderjan, Thomas H. and Tim Preston, 2013. '2012 Excavations at the Site of Xnoha,' *The 21st annual report of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 23-32

Guderjan, Thomas H., Jeffery Baker, and Robert J. Lichtenstein, 2003. "Environmental and Cultural Diversity at Blue Creek." *Heterarchy, Political Economy, and the Ancient Maya: The Three Rivers Region of the East-Central Yucatan Peninsula* Ed. Vernon L. Scarborough, Fred Valdez Jr. Nicholas Dunning.

pgs. 77-91 The University of Alabama Press

Guderjan, Thomas H., Helen Haines, Micheal Lindeman, Shirley Mock, Ellen Ruble, Froyla Salam and Lea Worchester, 1993. Excavations at the Blue Creek Ruin Northwestern Belize 1992 Interim Report, Ed. Thomas Guderjan

Guderjan, Thomas H., Helen Haines, Mike Lindeman, Ellen Rube, Dale Pastrana, Pam Weiss, 1994. 'Excavations at the Blue Creek Ruin Northwestern Belize 1993 Interim Report', Ed. Thomas Guderjan

Guderjan, Thomas H., Robert Lichtenstien, C. Colleen Hanratty 2003. "Elite Residences at Blue Creek, Belize." *Maya Palaces and Elite Residences.* Ed. Jessica Joyce Christie pp. 13-45 University of Texas Press

Guderjan, Thomas H., Jason W., Barrett, Timothy Beach, Steven Bozarth, William T. Brown, Bruce Dickson, Pieta Greaves, Sheryl Luzzadder-Beach, Tim Preston, Stephen Reichardt, Robert Warden and Marc Wolf, 2010. 'A Summary of Current Research in Northwestern Belize,' *The 2009 Season of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan pp. 5-16

Hagerty, T.W., 1996. The influence of English on the Spanish language of Belize. In *Belize: Selected proceedings from the second interdisciplinary conference* (pp. 131-142). Edited by Michael D. Phillips. University Press of America.

Haines, Helen R., 1996a. 'Excavations at Structure 9' *Archaeological Research at Blue Creek Belize, Progress Report of the Fourth (1995) Field Season*. Ed. Thomas H. Guderjan, W. David Driver, and Helen R. Haines pp. 59-68

--1996b. 'A Preliminary Discussion of Preclassic Midden Deposits at Structure 9.' *Archaeological Research at Blue Creek Belize, Progress Report of the Fourth (1995) Field Season*. Ed. Thomas H. Guderjan, W. David Driver, and Helen R. Haines pp. 85-108

---1997. 'Continuing Excavations of Preclassic Deposits at Structure 9,' *The Blue Creek Project: Working Papers from the 1996 Field Season,* Ed. W. David Driver, Heather . Clagett, and Helen R. Haines pp. 14-26

Haines, Helen R., and Rebecca Blom, 2002. 'Excavations of Structure 9-sub.' *Working Papers of the Blue Creek Project 1998 & 1999 Field Seasons,* Ed. Thomas Guderjan. pp. 59-64

Haines, Helen R. and David Wilhelmy, 1999. 'Excavations at the Structure 25 Courtyard,' *The Blue Creek Project: Working Papers from the 1997 Season*. Ed. W. David Driver, Helen R. Haines and Thomas H. Guderjan pp. 49-58

Hammond, Gail, 2012. 'The Nojol Nah Settlement Zone: The 2010 and 2011 Seasons,' *The 20th annual report of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize, Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 41-128

---2013. 'Tulix Mul Courtyard Group – 2012 Field Season Report,' *The 21st annual report of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 142-226

Hammond, Gail A 2015. *Ancient Maya settlement and the Alacranes Bajo: Landscape and Communities in the Three Rivers Region.* PhD Thesis, Institute of Archaeology, University College London, London England.

Hammond, Gail, Shannon Vance, and Carl Williford, 2014. 'Continuing excavations at the edge of the Alacranes Bajo: the 2013 season at Tulix Mul,' *The 22nf annual report of the Blue Creek Archaeological Project.* Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 441-474

Hammond, N., Clarke, A. and Donaghey, S., 1995. The long goodbye: middle Preclassic Maya archaeology at Cuello, Belize. *Latin American Antiquity*, pp.120-128.

Hanratty, Colleen C., 2002. 'Excavations in the Structure 37 Plazuela,' *Working Papers of the Blue Creek Project 1998 & 1999 Field Seasons,* Ed. Thomas Guderjan. pp. 73-81

---2008. 'Excavations at Kin Tan. Blue Creek Archaeological Project: Report of 2007 Fieldwork,' *Submitted to the Institute of Archaeology, National Institute of Culture and History, Belmopan*. Ed. Thomas H. Guderjan, Timothy Beach, Colleen Hanratty, Sheryl Luzzadder-Beach, Tim Preston and Steve Shaw. pp. 31-40

---2010. 'Collapse and Post-Classic Processes at Blue Creek.' *The 2009 Season of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan pp.17-28

Hanratty, Colleen C., and W. David Driver, 1997. 'Excavations at the Structure 37 Courtyard Group.' *The Blue Creek Project: Working Papers from the 1996 Field Season,* Ed. W. David Driver, Heather . Clagett, and Helen R. Haines pp. 51-60

Hansen, R.D., 1990. *Excavations in the Tigre Complex, El Mirador, Peten, Guatemala*. New World Archaeological Foundation, Brigham Young University.

---2001. "The first cities: The beginnings of urbanization and state formation in the Maya Lowlands." *Maya: Divine Kings of the Rainforest* Ed. Nikolai Grube, Konemann Press, Verlag, Germany, pp. 50-65.

Haviland, William A., 1967. Stature at Tikal, Guatemala: implications for ancient Maya demography and social organization. *American Antiquity*, pp.316-325.

--1972. “Estimates of Maya Population: Comments on Thompson’s Comments.” *American Antiquity* 37: 261-262

Headrick, Annabeth, 2009. *The Teotihuacan Trinity: The Sociopolitical Structure of an Ancient Mesoamerican City*. University of Texas Press, Austin.

Healy, Paul F., 2007. ‘The Anthropology of Mesoamerican Caves.’ *Reviews in Anthropology*. Vol. 36 pp. 245-278

Healy Paul F, Jamie J. Awe, and Hermann Helmuth, 1998 “An Ancient Maya Multiple Burial at Caledonia Cayo District, Belize.” *Journal of Field Archaeology*. 25(3): pp. 261-274

Hendon, Julia, 1991, “Status and Power in Classic Maya Society: An Archaeological Study.” *American Anthropologist* Vol. 93 No.4 pp. 894-918

Hillson, Simon, 1979 ‘Diet and Dental Disease,’ *World Archaeology*, *Vol. 11 No. 2, Food and Nutrition*, pp. 147-162

---1991. ‘Dental Histology as an Index of Past Community Health.’ *Health in Past Societies: Biocultural interpretations of human skeletal remains in archaeological contexts.* pgs. 53-66 Ed. Helen Bush and Marek Zvelebil BAR International Series 567

---1996. *Dental Anthropology*, Cambridge University Press

---2005. *Teeth*. Cambridge Manuals in Archaeology. Cambridge University Press
Hooton, E.A., 1930. *Indians of Pecos Pueblo: A study of their skeletal remains*. National Archaeological Database, the Digital Archaeological Record

Hooton, Earnest, 1940. ‘Skeletons from the cenote of sacrifice at Chichen Itza,’ *The Maya and Their Nieghbors*. Ed. C.L. Hay, Appleton-Century, New York, pp. 272-280

Hoppa, R.D., 2002. ‘Paleodemography: looking back and thinking ahead.’ *CAMBRIDGE STUDIES IN BIOLOGICAL AND EVOLUTIONARY ANTHROPOLOGY*, pp.9-28.

Hoppa, Robert D. and Charles M. FitzGerald, 1999. ‘From head to toe: integrating studies from bones and teeth in biological anthropology.’ *Human growth in the* *past: Studies from bones and teeth* Ed. Robert D. Hoppa and Charles M. FitzGerald Cambridge University Press. pp. 1-32

Holland, Thomas D., and Micheal J. O'Brien, 1997. 'Parasites, Porotic Hyperostosis, and the Implications of Changing Perspectives,' *American Antiquity*. Vol. 62. No. 2 pp. 183-193.

Houston, Stephen, 2009. 'A Splendid Predicament: Young Men in Classic Maya Society,' *Cambridge Archaeology Journal* 19 pp. 149-178

Houston, Stephen, and Takeshi Inomata 2009. *The Classic Maya*. Cambridge University Press.

Houston, Stephen and David Stuart, 1992. 'On Maya hieroglyphic literacy.' *Current Anthropology*. (33)5: pp: 589-593

---1996. Of gods, glyphs and kings: divinity and rulership among the Classic Maya. *Antiquity*, *70*(268), pp.289-312.

Houston, S., Robertson, J., Stuart, D., Brody, J., Fought, J.G., Hofling, C.A., Mc Anany, P.A., Pohl, J.M., Stone, A., Storniolo, J. and Taladoire, E., 2000. The Language of Classic Maya Inscriptions 1. *Current anthropology*, *41*(3), pp.321-356.

Houston, Stephen D., Hector Escobedo, Mark Child, Charles Golden, and A. Rene Munoz, 2003. 'The Moral Community: Maya Settlement Transformation at Piedras Negras, Guatemala.' *The Social Construction of Ancient Cities*, Ed. Monica Smith pp. 212-253 Smithsonian Institution Press, Washington D.C.

Houston, Stephen, John Robertson and David Stuart, 2000. 'The Language of Classic Maya Inscriptions,' *Current Anthropology*. Vol. 41(3) pp. 321-356.

Hutson, S.R., Hixson, D.R., Magnoni, A., Mazeau, D. and Dahlin, B., 2008. Site and community at Chunchucmil and ancient Maya urban centers. *Journal of Field Archaeology*, *33*(1), pp.19-40.

Hudson, Scott, R., Aline Magnoni, and Travis W. Stanton, 2004. 'House Rules? The practice of social organization in Classic-period Chunchunmil, Yucatan, Mexico.' *Ancient Mesoamerica* Vol. 15 Cambridge University Press pp. 75-92

Hughes, Barbara, 2009. 'Excavations at RS-26,' *Seventieth Sojourn: The 2008 Season of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology, National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan, Jason Barrett, and Tim Preston pp. 41-44

Hughes, Chris E., 2010. *Biological Variation Among Modern Maya of Guatemala: Discerning Population Structure and Related Sociohistoric Factors.* PhD Dissertation, University of California, Santa Cruz, Santa Cruz California

Humphrey, L.T. 1998. 'Growth patterns in the modern human skeleton.' *American Journal of Physical Anthropology* 105: 57-72.

Huss-Ashmore, Rebecca, Alan H. Goodman, and George J. Armelagos, 1982. 'Nutritional Inference from Paleopathology.' *Advances in Archaeological Method and Theory* Vol. 5 pp. 395-474

Iannone, Gyles and John Morris, 2009. 'Ancient Maya Socio-Political Organization: Perspectives From Belizean Archaeology.' *Research Reports in Belizean Archaeology: Papers of the 2008 Belize Archaeology Symposium*. Institute of Archaeology, Belmopan Cayo District, Belize, ed. John Morris, Sherilyne Jones, Jaime Awe, George Thompson and Christophe Helmke. Pages 3-14.

Inomata, Takeshi and Laura R. Stiver 1998. 'Floor assemblages from burned structures at Aguateca, Guatemala: A study of Classic Maya households.' *Journal of Field Archaeology*, *25*(4), pp.431-452.

Iscan, M.Y. and Loth, S.R 1986. 'Estimation of age and determination of sex from the sternal rib.' *Forensic osteology: advances in the identification of human remains. Springfield, IL: Charles C. Thomas*, pp.68-89.
--- 1986. 'Sexual dimorphism in the femur and tibia.' *Forensic Osteology: Advances In Identification of Human Remains*. *Springfiled, IL: Charles C Thomas,* pp.68-89

---1989. 'Osteological manifestations of age in the adult.' *Reconstruction of life from the skeleton*, pp.5-18.

Iscan M., Susan R. Loth, and Ronald K. Wright, 1984. 'Age Estimation form the Rib by Phase Analysis: White Males.' ASTM International pp. 1094-1104

--- 1985. 'Age Estimation form the Rib by Phase Analysis: White Females.' ASTM International pp. 853-863

Jacobi, Keith P., and Marie Elaine Danforth, 2002. 'Analysis of interobserver scoring patterns in porotic hyperostosis and cribra orbitalia.' *International Journal of Osteoarchaeology* Vol. 12: 4 pp. 248-258

Jackes, M., 2000. 'Building the bases for paleodemographic analysis: adult age determination.' *Biological Anthropology of the Human Skeleton, Wiley-Liss, New York*, pp.417-466.

Jangde, S., Arya, R.S. and Paikra, S., 2015. COMPLETE FUSION OF FIFTH LUMBAR VERTEBRA WITH SACRUM: AN OSTEOLOGICAL CASE REPORT.

Jones, G.D., 1989. *Maya resistance to Spanish rule: time and history on a colonial frontier*. University of New Mexico Press, Albuquerque, New Mexico

Joyce, Rosemary A. 2000. *Gender and Power in Prehispanic Mesoamerica*. University of Texas Press, Austin.

Jurmain, Robert D., and Lynn Kilgore, 1995. 'Skeletal evidence of osteoarthritis: a palaeopathological perspective.' *Annals of Rheumatic Diseases* Vol. 54. pp. 443-450

Kanipe, Hayley E. and Jason J. Gonzalez, 2003. 'Small Sites Versus Large Sites: Questioning Maya Political and Economic Settlement Relationships,' *Blue Creek Regional Political Ecology Project: 2001 and 2002 Research Summaries*. Ed. John C. Lohse, Submitted to The Institute of Archaeology, Government of Belize, Belmopan, pp. 44-49

Kemkes-Grottenthaler, A.R.I.A.N.E., 2002. 'Aging through the ages: historical perspectives on age indicator methods.' *CAMBRIDGE STUDIES IN BIOLOGICAL AND EVOLUTIONARY ANTHROPOLOGY*, pp.48-72.

Kerr, Barbara, and Justin Kerr, 2005. 'The Way of God L: the Princeton Vase revisited,' Record of the Princeton Art Museum 64(2005) pp. 71-79

Kindon, Andrew William, 2002. *Classic Maya Sociopolitical Organization and Settlement Patterns in the Maya Mountains of Southern Belize.* PhD Dissertation. University of California, Los Angeles, Los Angeles California

Kirchhoff, Paul 1943. 'Mesoamerica, sus limites geographicos, composicion etnica y caracteres culturales.' *Acta Americana* 1:92-107

Knudson, Kelly J. and Christopher M. Stojanowski, 2008, 'New Directions in Bioarchaeology: Recent Contributions to the Study of Human Social Identities.' *Journal of Archaeological Research* Vol. 16 No. 4 pp. 397-432

Kotthof, Lars, 2013. 'The design and implementation of an interactive atlas of Maya sites,' Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 367-390

Kroll, Alex, 2009. 'Excavations at U Xulil Beh,' *Seventieth Sojourn: The 2008 Season of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology, National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan, Jason Barrett, and Tim Preston pp. 45-46

Krause, Samantha, and Tara Majewski 2011. 'Test Excavations at BOP,' *The 19th annual report of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan pp. 199-218

Krause, Samantha and Justin Telepak 2014. 'Preliminary Survey Efforts at Cochal,' *The 22nf annual report of the Blue Creek Archaeological Project.* Submitted to the

Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 481-484

Kumar A and R. Shane Tubbs, 2011, 'Spina Bifida: A Diagnostic Dilemma in Paleopathology,' *Clinical Anatomy* 24:19-33

Kurjack, Edward B. 2003. 'Palace and Society in the Northern Maya Lowlands.' *Maya Palaces and Elite Residences.* Ed. Jessica Joyce Christie pp. 274-290.

Lallo, J.W., Armelagos, G.J. and Mensforth, R.P., 1977. The role of diet, disease, and physiology in the origin of porotic hyperostosis. *Human Biology*, pp.471-483.

Lalonde, Dane, 2003. 'Ixno 'Ha 2002 Season Excavation Summary.' *Blue Creek Regional Political Ecology Project: 2001 and 2002 Research Summaries*. Ed. John C. Lohse, Submitted to The Institute of Archaeology, Government of Belize, Belmopan, pp. 50-52

Larsen, Clark Spencer, 1995, 'Biological Changes in Human Populations with Agriculture,' *Annual Review of Anthropology*, Vol. 24 pp. 185-213

---2000, *Skeletons in our closet: revealing our past through bioarchaeology*. Princeton University Press.

---2002, 'Bioarchaeology: The Lives and Lifestyles of Past People,' *Journal of Archaeological Research*, Vol. 10 No. 2 pp. 119-166

---2003. *Bioarchaeology: Interpreting behavior from the human skeleton*. Cambridge Studies in Biological and Evolutionary Anthropology. Cambridge University Press.

---2012 'Forward,' *The Bioarchaeology of Individuals*. University Press of Florida. Ed. Ann L. W. Stodder and Ann M. Palkovich

Las Casas, B., 1992. *A Short Account of the Destruction of the Indies*. Penguin UK.

Leatherman T.L., 1998. 'Gender differences in health and illness among rural populations in Latin America.' *Sex and Gender in Paleopathological Perspective*, p.114.

Lee-Thorpe, J.A. 2008. 'On isotopes and old bones.' *Archaeometry* 50: 925-950.

Lefebvre, H. (1974). 1991. *The production of space*, Willey-Blackwell Publishers, Hoboken New Jersery

Lentz, 1991, 'Maya Diets of the Rich and Poor: Paleoethnobotanical Evidence from Copán,' *Latin American Antiquity*, Vol. 2 No. 3 pp. 269-287

Lewis, M.E., 2007. *The bioarchaeology of children: perspectives from biological and forensic anthropology* (Vol. 50). Cambridge University Press.

Lichtenstien, Robert J., 1996. 'Preliminary Report of the Structure 19 Courtyard' *Archaeological Research at Blue Creek Belize, Progress Report of the Fourth (1995) Field Season*. Ed. Thomas H. Guderjan, W. David Driver, and Helen R. Haines pp. 78-84

---1997. 'The Structure 19 Courtyard,' *The Blue Creek Project: Working Papers from the 1996 Field Season,* Ed. W. David Driver, Heather . Clagett, and Helen R. Haines pp. 39-50

---1999. 'The Blue Creek Settlement Testing Program,' *The Blue Creek Project: Working Papers from the 1997 Season*. Ed. W. David Driver, Helen R. Haines and Thomas H. Guderjan pp. 59-70

---2002a. 'The Blue Creek Project Classification System,' Working Papers of the Blue Creek Project 1998 & 1999 Field Seasons,' Ed. Thomas Guderjan. pp. 37-48

---2002b. 'Excavations in the Structure 41 Courtyard,' *Working Papers of the Blue Creek Project 1998 & 1999 Field Seasons,* Ed. Thomas Guderjan. pp. 85-94

Lichtenstien, Robert J., and C. Colleen Hanratty, 2002. 'An Introduction to the Western Group.' *Working Papers of the Blue Creek Project 1998 & 1999 Field Seasons,* Ed. Thomas Guderjan. pp. 69-72

Liebe-Harkort, Carola, 2012a. 'Exceptional rates of dental caries in a scandinavian Early Iron Age population—A study of dental pathology at Alvastra, Östergötland, Sweden.' *International journal of osteoarchaeology*, *22*(2), pp.168-184.

-- 2012b. 'Cribra orbitalia, sinusitis and linear enamel hypoplasia in Swedish Roman Iron Age adults and subadults. *International journal of osteoarchaeology*,' *22*(4), pp.387-397.

Lieverse, Angela, 1999. 'Diet and the Aetiology of Dental Calculus.' *International Journal of Osteoarchaeology* 9: pp. 219-232

Lincoln, Hollie, 2016. 'Structures 79 and 80 at Xnoha,' *The 24th Annual Report of the Blue Creek Archaeological Project*. Ed. Thomas H. Guderjan and C. Colleen Hanratty, Submitted to the Institute of Archaeology, National Institute of Culture and History, Belmopan, Belize.

Lohse, Jon C., 2003 'Project Overview.' *Blue Creek Regional Political Ecology Project: 2001 and 2002 Research Summaries*. Ed. John C. Lohse, Submitted to The Institute of Archaeology, Government of Belize, Belmopan, pp. 3-19

---2004. 'Blue Creek Regional Political Ecology Project 2003 Season Summary—Project Overview.' *Blue Creek Regional Political Ecology Project: 2003 Research Summary*. Ed. John C. Lohse, Submitted to The Institute of Archaeology, Government of Belize, Belmopan, pp. 1-14

---2005. '2004 Season of the Blue Creek Regional Political Ecology Project: General Overview,' *2004 Season Summaries of the Blue Creek Regional Political Ecology Project, Upper Northwestern Belize*. Submitted to the Institute of Archaeology, National Institute of Culture and History, Belmopan, Belize pp. 1-15

Lohse, Jon C., Jimmy Barrera and Antonio Padilla, 2005. '2004 Season Excavations in the Gran Cacao Ballcourt, Northwestern Belize,' *2004 Season Summaries of the Blue Creek Regional Political Ecology Project, Upper Northwestern Belize*. Submitted to the Institute of Archaeology, National Institute of Culture and History, Belmopan, Belize pp. 54-107

Loten, H.S. and Pendergast, D.M., 1984. *A lexicon for Maya architecture* (No. 8). Royal Ontario Museum.

Lorentz, K., 2008. 'From Bodies to Bones and Back: theory and human bioarchaeology.' *Between Biology and Culture. Cambridge Studies in Biological and Evolutionary Anthropology*, *56*, pp.273-303.

Lovejoy, Owen C., Richard S. Meindl, Thomas R. Pryzbeck, and Robert P. Mensforth, 1985. 'Chronological Metamorphosis of the Auricular Surface of the Ilium: A New Method for the Determination of Adult Skeletal Age at Death.' *American Journal of Physical Anthropology* Vol. 68. pp. 15-28.

Lovell, N.C., 2000. 'Paleopathological description and diagnosis.' *Biological anthropology of the human skeleton. New York: Wiley-Liss. pp*. pp.217-248.

Lucero, Lisa, 1999. 'Classic Lowland Maya Political Organization: A Review.' *Journal of American Prehistory.* 13(2): pp. 211-263

Lucero, Lisa J. and Sherry Gibbs, 2007. 'The Creation and Sacrifice of Witches in Classic Maya Society' *New Perspectives on Human Sacrifice and Ritual Body Treatments in Ancient Maya Society.* Ed. Vera Tiesler and Andrea Cucina pp. 45-73 Springer, New York

Lund, Erin Suzanne, 2003. 'An Anthropological Examination of Classic Maya Burials from Moho Cay, Belize: Skeletal and Dental Evidence of Demography, Diet, and Health.' Submitted to the graduate faculty of the LSU in partial fulfilment of the requirements for the degree of Master of Arts.

Luzzadder-Beach, Sheryl, Tim P. Beach and Nicholas P. Dunning, 2012. 'Wetland Fields as Mirrors of Drought and the Maya Abandonment,' *The 20th annual report of the Blue Creek Archaeological Project*. Submitted to the Institute of

Archaeology National Institute of Culture and History, Belmopan, Belize, Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 249-270

Maggiano, Isabel S. Micheal Schultz, Horst Kierdorf, Thelma Sierra Sosa, Corey M. Maggiano, and Vera Tiesler Blos, 2008. 'Cross-Sectional Analysis of Long Bones, Occupational Activities and Long-Distance Trade of the Classic Maya from Xcambo—Archaeological and Osteological Evidence.' American Journal of Physical Anthropology 136: 470-477.

Mann, Robert W and David R. Hunt *Photographic Regional Atlas of Bone*, Second Edition, Charles C Thomas Publisher LTD. Springfield Illinois

Maclellan, Erin. 2011. 'Linear Enamel Hypoplasia: What Can it Say About the Condition of Childhood?' *Totem: The University of Western Ontario Journal of Anthropology,* Vol 13 Issue 1 pp. 41-52

Marcus, Joyce, 1993. Ancient Maya political organization. *Lowland Maya civilization in the eighth century AD*, pp.111-183.

---1995. 'Where is Lowland Maya Archaeology Headed?' *Journal of Archaeological Research,* Vol. 3 No. 1 pp. 3-53

Marquez Morfin Lourdes, Robert McCaa, Rebecca Storey, and Andres Del Angel, 2002. 'Health and Nutrition in Pre-Hispanic Mesoamerica,' *The Backbone of History: Health and Nutrition in the Western Hemisphere*. Editors: Richard H. Steckel and Jerome C. Rose. Cambridge University Press New York NY 307-338

Marquez Morfin, Louis and Rebecca Storey 2008. 'From Early Village to Regional Center in Mesoamerica: An Investigation of Lifestyles and Health.' *Ancient Health* Ed. Mark Nathen Cohen and Gilian M. M. Crane-Kramer pp. 181-188

Martin, S. and Grube, N., 2008. *Chronicle of the Maya kings and queens: Deciphering the dynasties of the ancient Maya*. Thames & Hudson.

Masson, Marilyn A. 2002. Community Economy and the Mercantile Transformation in Postclassic Northeastern Belize." *Ancient Maya Political Economies*. Editors Marilyn A. Masson and David A. Freidel AltaMira Press Walnut Creek CA pp: 335-364

Masson, M.A., Hare, T.S. and Lope, C.P., 2010. ml Postclassic Maya Society Regenerated at Ife Mayapan. *After collapse: The regeneration of complex societies*, p.188.

Mastroprieto, Greg and Tim Preston, 2010. 'Summary of Fieldwork on Structures 15 & 17 Chum Balam-Nal, Operation 03, 2009 Field Season,' *The 2009 Season of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology

National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan pp. 37-40

Masur, Lindi J., 2011. 'Stature Trends in Ancient Maya Populations: Reexamining Studies from Tikal and Alter de Sacrificios,' *Totem: The University of Western Ontario Journal of Anthropology,* Vol. 17 Issue 1 pp. 13-22

Maurer, Kathryn Elizabeth, 1997. *Ancient Images Modern Visions: Representations of Maya Identity in Belize.* University of California Los Angeles, Los Angeles California

Mayes, A.T., and S. B. Barber, 2008. 'Ostebiography of a High-status Burial form the Lower Rio Verde Valley of Oaxaca, Mexico,' *International Journal of Osteoarchaeology.* Vol. 18 pp. 573-588

Mays, Simon 1995. 'The Relationship between Harris Lines and other Aspects of Skeletal Development in Adults and Juveniles' *Journal of Archaeological Science* 22 pp. 511-520

---1999. 'Linear and appositional long bone growth in earlier human populations: a case study from Mediaeval England,' *Human Growth in the Past: Studies from Bones and Teeth*, Eds. Robert D. Hoppa and Charles M. Fitzgerald, Cambridge University Press, pp. 290-312.

---2008. 'Metabolic Bone Disease.' *Advances in Human Paleopathology*. Ed. Ron Pinhasi and Simon Mays John Wiley and Sons Ltd. West Sussex, England. pp. 215-252

Mays, S. and Cox, M. 2000. 'Sex determination in skeletal remains.' *Human Osteology*. Eds. Cox, M. & Mays, S. London, Greenwich Medical, pp. 117-130.

McAnany, Patricia, 2014. *Living with the Ancestors: Kinship and Kingship in Ancient Maya Society.* Cambridge University Press

McAnany, Patricia and Tomas Gallareta Negron 2010. 'Bellicose Rulers and Climatological Peril?: Retrofitting Twenty-First Century Woes on Eighth-Century Maya Society,' *Questioning Collapse: Human Resilience, Ecological Vulnerability, and the Aftermath of the Empire*

McAnany, P.A., Thomas, B.S., Morandi, S., Peterson, P.A. and Harrison, E., 2002. 'Chapter Five Praise the Ajaw and Pass the Kakaw: Xibun Maya and the Political Economy of Cacao.' *Ancient Maya political economies*, p.123-139.

McAnany, Patricia, Rebecca Storey and Agela Lockard, 'Mortuary Ritual and Family Politics at Formitive and Early Classic K'axob, Belize.' *Ancient Mesoamerica* 1999 pp. 129-146

McAnany, Patricia, Thomas Morandi, Peterson and Harrison 2002. ‘Praise the Ajaw and Pass the Kakaw: Xibun Maya and the Political Economy of Cacao.’ *Ancient Maya Political Economies*. Editors Marilyn A. Masson and David A. Freidel AltaMira Press Walnut Creek CA pp: 123-139

McGuire, R.H. and Schiffer, M.B., 1983. A theory of architectural design. *Journal of Anthropological Archaeology*, *2*(3), pp.277-303.

McLellan. Sam, 2014a. ‘Excavations at Structure 1, Xnoha,’ *The 22nf annual report of the Blue Creek Archaeological Project.* Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 23-52

---2014b. ‘An Overview of the Maya Research Program’s 2012 Excavation of Xnoha,’ *The 22nf annual report of the Blue Creek Archaeological Project.* Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 165-190

McNatt, Logan, 1996. ‘Cave Archaeology of Belize.” *Journal of Cave and Karst Studies 58(2)* pp. 81-99

McIlvaine, B.K., 2015. Implications of reappraising the iron-deficiency anemia hypothesis. *International Journal of Osteoarchaeology*, *25*(6), pp.997-1000.

McVicker, D., 2012. Figurines are us? The social organization of Jaina Island, Campeche, Mexico. *Ancient Mesoamerica*, *23*(02), pp.211-234.

Mead, Kent 2015. ‘2014 Excavations at Ma’ Pitz Nah, Xnoha,’ The *23rd annual report of the Blue Creek Archaeological Project.* Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. C. Colleen Hanratty and Thomas H. Guderjan pp. 83-110

Mead, Kent, Greg Mastropietro, and Ian Lemasters 2014. ‘Piz Nah Or Ma’ Pitz Nah, That is the Question: Preliminary Report of the 2013 Excavations at a Purported Ball Court at Xnoha,’ *The 22nf annual report of the Blue Creek Archaeological Project.* Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 53-82

Meindl, R.S., Lovejoy, C.O., Mensforth, R.P. and Carlos, L.D. 1985. ‘Accuracy and direction of error in the sexing of the skeleton.’ *American Journal of Physical Anthropology* 68: 79-85.

Meindl, Richard S., and Katherine F. Russell 1998 ‘Recent Advances in Method and Theory in Paleodemography.’ *Annual Review of Anthropology* 27: 375-399

Mensforth, Robert, C. Owen Lovejoy, John W. Lallo and George J. Armelagos, 1978. 'The Role of Constitutional Factors, Diet, and Infectious Disease in the Etiology of Porotic Hyperostosis and Periosteal Reactions in Prehistoric Infants and Children.' *Medical Anthropology*, ed. Robert Ness, Gretel H. Pelto and Pertti J. Pelto, Issue 1. New York

Meyer, Christian, Nicole Nickisch, Petra Held, and Barbara Fritsch, 2011. 'Tracing patterns of activity in the human skeletal: An overview of methods, problems, and limits of interpretation.' *HOMO: Journal of Comparative Human Biology,* Vol 62 pp. 202-217

Mickleburgh, Hayley L., and Jamie Pagan-Jimenez, 2012. 'New insights into the consumption of maize and other food plants in the pre-Columbian Caribbean form starch grains trapped in human dental calculus,' *Journal of Archaeological Science* 39: 2468-2478

Micozzi, Marc S. 1991. *Postmortem Changes in Human and Animal Remains, A systematic Approach*. Charles C Thomas Publisher Springfield Illinois

Milbrath, S. and Lope, C.P., 2003. REVISITING MAYAPAN: Mexico's last Maya capital. *Ancient Mesoamerica*, *14*(01), pp.1-46.

Miller A.G., 1985. The Postclassic sequence of Tancah and Tulum, Quintana Roo, Mexico. *The Lowland Maya Postclassic*, Ed. Arlene Chase and Prudence Rice, University of Texas Press, Austin pp.31-49.

Miller, Katherine Anne, 2015. *Family, 'Foreigners', and Fictive Kinship: a Bioarchaeological Approach to Social Organization at Late Classic Copán.* PhD Dissertation, Arizona State University, Phoenix Arizona

Mizoguchi, Yuji and Seiichi Nakamura, 2006. 'Maya skeletal remains from the Copán and El Puente sites in Honduras,' *Anthropological Science,* Vol. 114. pp. 75-88.

Moodie, Steven J. M., 2016. 'The Excavations at Structure 103, Xnoha,' *The 24th Annual Report of the Blue Creek Archaeological Project*. Ed. Thomas H. Guderjan and C. Colleen Hanratty, Submitted to the Institute of Archaeology, National Institute of Culture and History, Belmopan, Belize.

Mosothwane, Morongwa N., and Maryna Steyn, 2004. 'Palaeodemography of the Early Iron Age Toutswe Communities in Botswana,' *The South African Archaeological Bulletin,* Vol. 59 No. 180 pp. 45-51

---2009. 'In sickness or in health? Assessment of Early Iron Age human skeletons from Toutswe sites, east central Botswana.' *International Journal of Osteoarchaeology*, *19*(1), pp.66-77.

Murray, H.W., Berman, J.D., Davies, C.R. and Saravia, N.G., 2005. Advances in leishmaniasis. *The Lancet*, *366*(9496), pp.1561-1577.

Nawrocki, Stephen P. 1995 'Taphonomic Process in Historic Cemeteries' *Bodies of Evidence: Reconstructing History Through Skeletal Analysis*. Ed. Ann L. Grauer, John Wiley & Sons pp. 49-68

Neiburger, E.J., 2012. Jaded smiles: ancient Mayan dental inlays and today's Central American patients. *Journal of the Massachusetts Dental Society*, *60*(4), pp.36-9.

Nelson, M.C., Glowacki, D. and Smith, A., 2002. The impact of women on household economies: A Maya case study. *In Pursuit of Gender: Worldwide Archaeological Approaches,* AltaMira, Walnut Creek, CA, pp.125-154.

Nikita, E. 2012. 'Estimation of the Original Number of Individuals Using Multiple Skeletal Elements.' *International Journal of Osteoarchaeology*. pp. 660-664

Nikita, E. and Lahr, M. 2011. 'Simple algorithms for the estimation of the initial number of individuals in commingled skeletal remains.' *American Journal of Physical Anthropology* 146: 4: 629–636.

Nystrom, Kenneth 2009. 'The Reconstruction of Identity: A Case Study from Chachapoya, Peru.' *Bioarchaeology and Identity in the Americas*. Ed. Knudson and Stojanowski University Press of Florida. pp. 82-102

---2011. 'Postmortem examinations and the embodiment of inequality in 19th century United States,' *International Journal of Paleopathology,* Vol 1 pp. 164-172
Nystrom, Kenneth C., and Jane E. Buikstra 2005. 'Trauma-Induced Changes in Diaphyseal Cross-Sectional Geometry in Two Elites from Copán, Honduras.' *American Journal of Physical Anthropology* 127

Nystrom, K.C., J.E. Buikstra, and E.M. Braunstein, 2005. 'Radiographic Evaluation of Two Early Classic Elites from Copán, Honduras,' *International Journal of Osteoachaeology.* Vol. 15. pp. 196-207

Nystrom, K.C., Goff, A. and Goff, M.L., 2005. 'Mortuary behaviour reconstruction through palaeoentomology: a case study from Chachapoya, Perú.' *International Journal of Osteoarchaeology*, *15*(3), pp.175-185.

O'Connell, L., 2004. 'Guidance on recording age at death in adults.' *Guidelines to the Standards for Recording Human Remains. Southampton/Reading: BABAO/Institute of Field Archaeologists. p*, pp.18-20.

Ogden, A., 2008. 'Advances in the palaeopathology of teeth and jaws.' *Advances in Human Palaeopathology*, pp.283-307.

Ortner, D.J. 2003. *Identification of Pathological Conditions in Human Skeletal Remains*. 2nd edition. Academic Press.

--- 2007a. 'Metobolic Disorders,' Ancient Health: Bioarchaeological Interpretations of the Human Past: Local, Regional, and Global Perspectives pp. 383-418

--- 2007b. 'Infectious Diseases: Introduction, Biology, Osteomyelitis, Periostitis, Brucellosis, Glanders, and Septic Arthritis,' Ancient Health: Bioarchaeological Interpretations of the Human Past: Local, Regional, and Global Perspectives pp. 179-226

--- 2008. 'Differential Diagnosis of Skeletal Lesions in Infectious Disease.' In: *Advances in Human Paleopathology* Ed. Ron Pinhasi and Simon Mays John Wiley and Sons Ltd. West Sussex, England. pp. 191-214.

---2011. 'Human Skeletal Paleopathology.' *International Journal of Paleoanthropology*. Vol. 1. pp. 4-11.

Ortner, D.J and B. Frohlich, 2007. 'The EB IA Tombs and Burials of Bab edh-Dhra, Jordan: A Bioarchaeological Perspective on the People,' *International Journal of Osteoarchaeology,* Vol 17 pp. 358-368

Ortner, Donald J., Erin H. Kimmerle, and Melanie Diez, 1999. 'Probable Evidence of Scurvy in Subadults From Archeological Sites in Peru,' *American Journal of Physical Anthropology,* Vol. pp. 321-323

Ortner, D.J. and Schutkowski, H., 2008. 'Ecology, culture and disease in past human populations.' *Between biology and culture. Cambridge University Press, Cambridge*, pp.105-128.

Outram, A.K., Knüsel, C.J., Knight, S. and Harding, A.F., 2005. 'Understanding complex fragmented assemblages of human and animal remains: a fully integrated approach.' *Journal of Archaeological Science*, *32*(12), pp.1699-1710.

Oxenham, Marc Fredrick, and Ivor Cavill, 2010. 'Porotic hyperostosis and cribra orbitalia: the erythropoietic response to iron-deficiency anaemia,' *Anthropological Science.* Vol. 18 No. 3 pp. 199-200

Padilla, Antonio Eduardo, 2007. *Akab Muclil: A Classic to Postclassic Hinterland Settlement in Northwestern Belize.* MA Thesis, Texas Tech University, Lubbock Texas

Padilla, Antonio, Molly Morgan, and Jon C. Lohse 2006. '2005 Excavations at Akab Muclil, Northwestern Belize,' *Final Season Summaries of the Blue Creek Regional Political Ecology Project: 2005 Investigations in Upper Northwestern Belize.* Ed. Jon

C. Lohse, Report Submitted to the Institute of Archaeology, National Institute of Culture and History, Belmopan, Belize, pp. 12-39

Pagden, A.R., 1975. Diego de Landa's Account of the Affairs of Yucatán. The Maya. *Phillip O'Hara Inc*.

Palka, J.W., 1997. Reconstructing classic maya socioeconomic differentiation and the collapse at dos pilas, peten, guatemala. *Ancient Mesoamerica*, *8*(02), pp.293-306.

---2014. *Maya Pilgrimage to Ritual Landscapes: Insights from Archaeology, History, and Ethnography*. UNM Press.

Parker Pearson, Mike 2003. *The Archaeology of Death and Burial* Sutton Publishing, Gloucestershire England.

Parmington, Alexander, 2014. 'Excavations Undertaken at Xnoha Building Group 78,' *The 22nd annual report of the Blue Creek Archaeological Project.* Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 101-164

---2015. 'Excavations Undertaken at Patio Group 78, Xnoha,' *The 23rd annual report of the Blue Creek Archaeological Project.* Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. C. Colleen Hanratty and Thomas H. Guderjan pp. 17-82

Pastrana, Alexander and Sam McLellen, 2015. 'Excavation of Structure 3, Xnoha,' *The 23rd annual report of the Blue Creek Archaeological Project.* Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. C. Colleen Hanratty and Thomas H. Guderjan pp. 127-136

Pastrana, Dale, 1996. 'Excavations of Structures 5 and 6,' *Archaeological Research at Blue Creek Belize, Progress Report of the Fourth (1995) Field Season*. Ed. Thomas H. Guderjan, W. David Driver, and Helen R. Haines pp. 43-58

---1999. 'An Analyssi of the Jades from Structure 4 Shaft Cashe,' *The Blue Creek Project: Working Papers from the 1997 Season*. Ed. W. David Driver, Helen R. Haines and Thomas H. Guderjan pp. 95-114

Pechenkina, E.A., Vradenburg, J.A., Benfer, R.A. and Farnum, J.F., 2007. 'Skeletal biology of the central Peruvian coast: consequences of changing population density and progressive dependence on maize agriculture.' *Ancient Health: Skeletal Indicators of Agricultural and Economic Intensification, University Press of Florida, Gainesville*, pp.93-112.

Pechenkina, Ekaterina A., Robert A. Benfer Jr., and Wang Zhijun, 2002. 'Diet and Health Changes at the End of the Chinese Neolithic: The Yangshao/Longshan

Transition in Shaanxi Province,' *American Journal of Physical Anthropology,* Vol. 117. pp. 15-36

Peck, Joshua J., 2013. 'Status, health, and lifestyle in Middle Iron Age Britain: A bioarchaeological study of elites and non-elites from East Yorkshire, Northern England.' *International Journal of Paleopathology*. Vol 3 pp. 83-94.

Pendergast, David M. 1981. 'Lamanai, Belize: Summary of Excavation Results, 1974-1980.' *Journal of Field Archaeology* 8(1):29-53

---1992. 'Noblesse Oblige: The Elites of Altun Ha and Lamanai, Belize'. *Mesoamerican Elites: An Archaeological Assessment* Ed. Diane Z. Chase and Arlen F. Chase, pp. 61-79 University of Oklahoma Press, London.

--- 1993, Worlds in Collision: The Maya-Spanish Encounter in Sixteenth and Seventeenth-Century Belize. In *The Meeting of Two Worlds: Europe and the Americas, 1492-1650*, ed. Warwick Bray, pp. 105-143. Proceedings of the British Academy 81. Oxford University Press, Oxford.

Pendergast, D.M. and Loten, H.S., 1990. *Excavations at Altun Ha, Belize, 1964-1970*. Royal Ontario Museum.

Phenice TW. 1969. 'A Newly Developed Visual Method of Sexing the Os Pubis.' *American Journal of Physical Anthropology.* 30:297-301

Pinhasi, Ron, 2008. 'Growth in Archaeological Populations,' *Advances in Human Paleopathology*, ed. Ron Pinhasi and Simon Mays John Wiley and Sons Ltd. West Sussex, England

Pinhasi, Ron, and Chryssi Bourbou, 2008. 'How Representative Are Human Skeletal Assemblages for Population Analysis?' *Advances in Human Paleopathology*, ed. Ron Pinhasi and Simon Mays John Wiley and Sons Ltd. West Sussex, England. pp. 31-44.

Pinhasi, Ron and Katy Turner, 2008. 'Epidemiological Approaches in Paleopathology.' Ron Pinhasi and Simon Mays Ed. *Advances in Human Paleopathology*. John Wiley and Sons Ltd. West Sussex, England. pp. 45-56.

Plumer, Hannah, 2014a. 'Excavations of a Terminal Classic Courtyard at Xnoha,' *The 22nd annual report of the Blue Creek Archaeological Project.* Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 83-100

---2014b. 'Bioarchaeological Analysis of Maya Bones Excavated in Alvin's Cave, Blue Creek, Belize, 2013 Field Season,' *The 22nf annual report of the Blue Creek Archaeological Project.* Submitted to the Institute of Archaeology National

Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 475-480

---2015. 'Osteological investigations into the skeletal populations at Xnoha and Tulix Mul excavated during 2013 and 2014,' The *23rd annual report of the Blue Creek Archaeological Project.* Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. C. Colleen Hanratty and Thomas H. Guderjan pp. 173-204

Popson, Colleen and Heather L. Clagett, 1999. 'Excavations at Chan Cahal,' *The Blue Creek Project: Working Papers from the 1997 Season*. Ed. W. David Driver, Helen R. Haines and Thomas H. Guderjan pp. 71-84

Powell, Mary Lucas, 1988. *Status and Health in Prehistory: A Case Study of the Moundville Chiefdom,* Smithsonian Institution Press, Washington

Preston, Tim, 2007. 'The Rosita Community: Examining Power Heterarchies within a Maya Polity,' *Blue Creek Archaeological Project: Report of the 2006 Fieldwork*. Submitted to the Institute of Archaeology, National Institute of Culture and History, Belmopan, Belize pp. 12-64

Preston, Tim and Thomas H. Guderjan, 2012. 'Excavations at the Remple Group, Blue Creek,' *The 20th annual report of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize, Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 17-28

Preston, Tim and Tara Majewski, 2010. 'Excavations of a fieldhouse in the Birds of Paradise fields,' *The 2009 Season of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan pp. 51-58

Preston, Tim and Greg Mastroprieto, 2010. 'Chum Balam-Nal, '*Where the Jaguar Rules'* Summary of Excavations on the CBN-13 Courtyard Group During the 2009 Field Season' *The 2009 Season of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan pp. 29-36

Price, Douglas T., James H. Burton, Robert J. Sharer, Jane R. Buikstra, Lori E. Wright, Loa P. Traxler, Katherine A. Miller, 2010. 'Kings and Commoners at Copán: Isotopic evidence for origins and movement in the Classic Maya period,' *Journal of Anthropological Archaeology*. Vol. 29(1) pp. 15-32

Prufer, Keith, and James E. Brady, 2005. *Stone Houses and Earth Lords: Maya Religion in the Cave Context.* David Carasco Series Mesoamerican Worlds, University Press of Colorado.

Quintana, P., V. Tiesler, M. Conde, R. Trejo-Tzab, C. Bolio, J. J> Alvarado-Gil, and D. Aguilar, 2014. 'Spectrochemical Characterization of Red Pigments Used in Classic Period Maya Funerary Practices.' Archaeometry, University of Oxford, pp. 1-15.

Quiroz, Carlos and Lindsay Deschenes, 2015. 'Excavation of Structure 77, Xnoha,' *The 23rd annual report of the Blue Creek Archaeological Project.* Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. C. Colleen Hanratty and Thomas H. Guderjan pp. 137-160

Redfield, R. and V. Rojas, 1934. *Chan Kom, a maya village*. Washington D.C., Carnegie Institution of Washington

Reents-Budet, Dorie and Joseph W. Ball, 1994. Painting the Maya Universe: royal ceramics of the Classic period, Duke University Press, Durham, NC

Reichs, K.J., 1986. 'Forensic implications of skeletal pathology: sex.' *Forensic Osteology. Charles C. Thomas. Springfield*, pp.112-142.

Renfrew, C. and Cherry, J.F., 1986. *Peer polity interaction and socio-political change*. Cambridge University Press.

Restall, M., 1997. *The Maya world: Yucatec culture and society, 1550-1850*. Stanford University Press. Standford California

Reyes, Leslie, 2009. 'Excavations at the RS-9 Patio Group.' *Seventieth Sojourn: The 2008 Season of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology, National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan, Jason Barrett, and Tim Preston pp. 35-40

Ricketson, O.G. and Ricketson, E.B., 1937. Uaxactun, Guatemala, Group E 1926–1937, Carnegie Institution of Washington, Publication. 477. *Washington: Carnegie Institution*.

Ringle, W.M., 2004. On the political organization of Chichen Itza. *Ancient Mesoamerica*, *15*(02), pp.167-218.

Roberts, Charlotte 2002 'Palaeopathology and Archaeology: The Current State of Play.' In: The archaeology of medicine. Oxford: Archaeopress, pp. 1-20 *BAR international series (1046)*

Roberts, C. 2000. 'Infectious disease in biocultural perspective: past, present and future work in Britain,' *Human Osteology.* Eds. Cox, M. & Mays, London, Greenwich Medical, pp. 145-162.

Roberts, C.A., Lewis, M.E. and Boocock, P., 1998. 'Infectious disease, sex, and gender: The complexity of it all,' *Sex and gender in paleopathological perspective*, pp.93-113.

Roberts, C.A. and Connell, B., 2004. Guidance on recording palaeopathology. *Guidelines to the Standards for Recording Human Remains*. Eds. Brinkley M and McKineley, J.I. Reading and Southhampton: British Association for Biological Anthropology and Osteoarchaeology and Institute of Field Archaeologists pp. 34-39

Roberts, C. and Manchester, K. 2005. *The archaeology of disease.* Stroud: Sutton

Robin, Cynthia. 2001. 'Peopling the Past: New perspectives on the ancient Maya,' *Proceedings of the National Academy of Sciences in the United States of America (PNAS)* vol. 98 pp. 18-21

--- 2002. Outside of houses: the practices of everyday life at Chan Nòohol, Belize. *Journal of Social Archaeology*, *2*(2), pp.245-268.

Rogers, Juliet and Tony Waldron, 1989. 'Infections in Paleopathology: The Basis of Classification According to Most Probable Cause.,' *Journal of Archaeological Science* 16, 611-625

Rose, Jerome C. Barbara A. Burnett, Michael S. Nassaney and Mark W. Blaeuer, 1984. 'Paleopathology and the Origins of Maize Agriculture in the Lower Mississippi Valley and Caddoan Culture Areas,' *Paleopathology at the Origins of Agriculture*. Mark Nathan Cohen and George J. Armelagos, Academic Press, Inc. New York. pp. 393-424

Rosenswig, Robert M. 2014. 'A Mosaic of Adaptation: The Archaeological Record for Mesoamerica's Archaic Period,' *Journal of Archaeological Research* pp. 115-162

---2015. 'Olmec Globalization: A Mesoamerican archipelago of complexity during the second millennium BCE. Handbook of Globalization and Archaeology, Routledge, London

Rothchild, Bruce, 2012, 'Extrapolation of the Mythology That Porotic Hyperostosis Is Caused by Iron Deficiency Secondary to Dietary Shift to Maize,' *Advances in Anthropology,* Vol. 2 No. 3 pp. 157-160

Rothschild, B.M. and Rothschild, C., 1994. Yaws, mine and ours: Treponemal disease transitions in prehistory. *Journal of Comparative and Human Biology*,*45*, p.S115.

Rue, David J., AnnCorinne Freter, and Diane A. Ballinger, 1989. 'The Caverns of Copán Revisited: Preclassic Sites in the Sesesmil River Valley, Copán, Honduras.' *Journal of Field Archaeology* Vol. 16: 4 pp. 395-404

Rytuba, James, 2003. "Mercury Mine Studies: Environmental Impact of Mercury Mines in the Coast Ranges, California." *Geologic Studies of Mercury by the U.S. Geological Survey.* U.S. Geological Survey Circlular 1248, U.S. Department of the Interior, U.S. Geological Survey. pp. 13-17
Sagebiel, Kerry Lynn, 2005. 'Blue Creek Regional Political Ecology Ceramic Report: 2004 Season,' *2004 Season Summaries of the Blue Creek Regional Political Ecology Project, Upper Northwestern Belize*. Submitted to the Institute of Archaeology, National Institute of Culture and History, Belmopan, Belize pp. 16-43

---2006. 'Blue Creek Regional Political Ecology Ceramic Report: 2005 Season,' *Final Season Summaries of the Blue Creek Regional Political Ecology Project: 2005 Investigations in Upper Northwestern Belize.* Ed. Jon C. Lohse, Report Submitted to the Institute of Archaeology, National Institute of Culture and History, Belmopan, Belize, pp. 76-95

Saul, Frank P., 1972. 'The human skeletal remains of Altar de Sacrificios. An osteobiographic analysis.' *Papers of the Peabody Museum.*, *63*(2), pp.3-123.

Saunders, Shelly R, D. Ann Herring and Gerald Boyce, 1995. 'Can Skeletal Samples Accurately Represent the Living Population They Come From? The St. Thomas' Cemetery Site, Belleville, Ontario.' *Bodies of Evidence: Reconstructing History Through Skeletal Analysis.* Ed. Anne L. Grauer Wiley-Liss, New York NY

Savoie, Greg, 2010a. 'Excavations at Structure 28, Blue Creek,' *The 2009 Season of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan pp.41-46

---2010b. 'Excavations at Structure 9874-3,' *The 2009 Season of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan pp. 47-50

---2014. 'Excavations at the Structure 28 Courtyard,' *The 22^{nf} annual report of the Blue Creek Archaeological Project.* Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 17-22

Schaefer, Maureen, Sue Black, and Louise Scheuer, 2000. *Developmental Juvenile Osteology*. Academic Press. London.

Scherer, Andrew K. 2004. *Dental Analysis of Classic Period Population Variability in the Maya Area.* PhD Dissertation, Texas A&M University, College Station Texas

---2007. 'Population Structure of the Classic Period Maya,' *American Journal of Physical Anthropology* 132: 367-380

---2015. *Mortuary Landscapes of the Classic Maya: Rituals of Body and Soul*. University of Texas Press, Austin, Texas

Scherer, Andrew K., Lori E. Wright, and Cassady J. Yoder, 2007, 'Bioarchaeological Evidence for Social and Temporal Differences in Diet at Piedras Negras, Guatemala,' *Latin American Antiquity*, Vol. 18 No. 1pp. 85-104

Scheuer, Louise, and Sue Black, 2000. *Developmental Juvenile Osteology*. Academic Press. London.

Schultz, Micheal, 2001. 'Paleohistopathology of Bone: A New Approach to the Study of Ancient Diseases,' *Yearbook of Physical Anthropology.* Vol. 44. pp. 106-147

Schultz, M., U. Timme, and T.H. Schmidt-Schultz, 2007. 'Infancy and Childhood in the Pre-Columbian North American Southwest—First Results of the Palaeopathological Investigation of the Skeletons from the Grasshopper Pueblo, Arizona,' *International Journal of Osteoarchaeology*, Vol. 17 Issue 4, pp. 369-379

Schutkowski, H. 1993. 'Sex determination of infant and juvenile skeletons: Morphognostic features,' *American Journal of Physical Anthropology* 107: 199-205
Scott, A.M. and Brady, J.E., 2005. 'Human remains in Lowland Maya caves: Problems of interpretation,' *Stone houses and earth lords: Maya religion in the cave context*, pp.263-284.

Seidemann, Ryan M. and Heather McKillop, 2007. 'Dental Indicators of Diet and Health for the Postclassic Coastal Maya of Wild Cane Cay, Belize,' *Ancient Mesoamerica,* Vol. 18 pp. 303-313

Serafin, Stanley 2007. 'Bioarchaeological Investigation of the Ancient Population Structure of Mayapan' *FAMSI*

Serafin, Stanley, Carlos Peraza Lope, and Eunice Uc Gonzalez, 2014. 'Bioarchaeological Investigation of Ancient Maya Violence and Warfare in Inland Northwest Yucatan, Mexico.' *American journal of Physical Anthropology* 154:140-151

Sharer, Robert 1992. 'The Preclassic Origin of Lowland Maya Sites,' *New Theories on the Ancient Maya*. University Museum Symposium Series, Vol. 3. University of Pennsylvania Ed. Elin C. Danien and Robert J. Sharer pp. 131-136

---2009. *Daily Life in Maya Civilization*. Greenwood Press, USA

Sharer, R.J. and Golden, C.W., 2004. Kingship and polity: Conceptualizing the Maya body politic. *Continuities and Changes in Maya Archaeology: Perspectives at the Millennium, Routledge, New York*, pp.23-50.

Sharer, Robert and Lola Traxler, 2006. *The Ancient Maya.* Stanford University Press, Stanford California.

Shennan, Stephen, 2008. *Quantifying Archaeology,* Edinburgh University Press
Siek, Thomas, 2013 'The Osteological Paradox and Issues of Interpretation in Paleopathology,' *Explorations in Anthropology*, pp. 1-10

Singh, Jagmahender and R. K. Pathak 2013. 'Sex and age related non-metric variation of the human sternum in a Northwest Indian postmortem sample: a pilot study.' *Forensic science international*, *228*(1), pp.181-e1

Smith, Augustus Ledyard, 1950. *Uaxactun, Guatemala: Excavations of 1931-1937.* Carnegie Institution of Washington, D.C. The Lord Baltimore Press, Baltimore Maryland.

Smith, M.O., Kurtenbach, K.J. and Vermaat, J.C., 2016. Linear enamel hypoplasia in Schroeder Mounds (11HE177): A Late Woodland period site in Illinois. *International Journal of Paleopathology*, *14*, pp.10-23.

Smith, Rita Kipp and Edward M Schortman 1989. 'The Political Impact of Trade in Chiefdoms,' *American Anthropologist*. 91(2) pp. 370385

Sofaer, J. 2006. 'Gender, bioarchaeology and human ontogeny,' *Social archaeology of funerary remains*. Eds. Knusel, C. and Gowland, R. Oxford: Oxbow: 155-67.

Spence, Michael W and Christine D. White 2009. Mesoamerican bioarchaeology: past and future. *Ancient Mesoamerica*, *20*(02), pp.233-240.

Spinden, H. J. 1928. *The Ancient Civilizations of Mexico and Central America*, Handbook Series, No. 3 American Museum of Natural History, New York

Spradley, M.K. and Jantz, R.L., 2011. Sex estimation in forensic anthropology: skull versus postcranial elements. *Journal of Forensic Sciences*, *56*(2), pp.289-296.

Steele, James, 2000. 'Skeletal Indicators of Handedness,' *Human Osteology in Archaeology and Forensic Science*. Ed. Margaret Cox and Simon Mays, Greenwich Medical Media Ltd. pp. 307-324

Steckel Richard H. and Jerome C. Rose, 2002. Introduction *The Backbone of History: Health and Nutrition in the Western Hemisphere*. Editors: Richard H. Steckel and Jerome C. Rose. Cambridge University Press New York NY 3-8

Steinbock, Ted R., 1976. *Paleopathological Diagnosis and Interpretation: Bone Disease in Ancient Human Populations*. Charles C Thomas Publisher, Springfield IL

Steyn, Maryna, and Maciej Henneberg, 1996, ‘Skeletal Growth of Children From the Iron Age Site at K2 (South Africa),’ *American Journal of Physical Anthropology*, Vol. 100 pp. 389-396

Storey, Rebecca, 1992. ‘The Children of Copán: Issues in paleopathology and paleodemography,’ *Ancient Mesoamerica*, Vol. 3. pp. 161-167.

---1992 *Life and Death in the Ancient City of Teotihuacan: A modern paleodemographic synthesis.* University of Alabama Press, Tuscaloosa, Alabama

---1998. ‘The mothers and daughters of a patrilineal civilization: the health of females among the Late Classic Maya of Copán, Honduras,’ *Sex and Gender in Paleopathological Perspective.* Eds. Anne L. Grauer and Patricia Stuart-Macadam, pp. 133-148. Cambridge University Press. New York NY

Storey, Rebecca and Randolph J. Widmer, 2012. ‘A Master Artisan?: Tribute to the Founder of a Teotihuacan Apartment Compound,’ *The Bioarchaeology of Individuals*. Ed. Ann L. W. Stodder and Ann M. Palkovich. The University Press of Florida, Gainesville Florida pp. 162-176

Stuart, G.E., 1992. Quest for decipherment: A historical and biographical survey of Maya hieroglyphic investigation. *New theories on the ancient Maya*, pp.1-63.

Stuart-Macadam, Patricia, 1991. ‘Anaemia in roman Britain: Poundbury Camp.’ *Health in past societies: biocultural interpretations of human skeletal remains in archaeological contexts*, *567*, pp.101101-113113.

---1992. ‘Anemia in Past Human Populations,’ *Diet, demography, and disease: changing perspectives on anemia*. Eds. Stuart-Macadam, P. and Kent, S., *Foundations of human behaviour.* Aldine De Gruyter, New York

---1998. ‘Iron Deficiency Anemia: exploring the difference.’ In: Anne L. Grauer and Patricia Stuart-Macadam, Ed. *Sex and Gender in Paleopathological Perspective*. pp. 45-63. Cambridge University Press. New York NY

Sullivan, Lauren A. 2002 ‘Dynamics of Regional Integration in Northwestern Belize.’ *Ancient Maya Political Economies*. Editors Marilyn A. Masson and David A. Freidel AltaMira Press Walnut Creek CA 197-222

Sullivan, Lauren A. and Kerry L. Sagebiel 2003. ‘Changing Political Alliances In the Three Rivers Region’, *Heterarchy, Political Economy, and the Ancient Maya: The Three Rivers Region of the East-Central Yucatan Peninsula* Ed. Vernon L. Scarborough, Fred Valdez Jr. Nicholas Dunning. pgs. 25-26 The University of Alabama Press

Sutter, R.C. and Cortez, R.J. 2005. ‘The nature of Moche human sacrifice: a bio-archaeological perspective.’ *Current Anthropology* 46: 521-549.

Tainter, Joseph A. 1978 ‘Mortuary Practices and the Study of Prehistoric Social Systems.’ *Advances in Archaeological Method and Theory* SpringerVol 1. Pp. 105-141

---1990. *The Collapse of Complex Societies*. Cambridge University Press, Cambridge UK

Thompson, Lauri McInnis, 2005. *A Comparitive Analysis of Burial Patterning: The Preclassic Maya Sites of Chiapa de Corzo, Kaminaljuyu, Tikal and Colha.* PhD Dissertation, University of Texas at Austin, Austin Texas

Thompson, Jennifer L., 2012. ‘A Neolithic Nomad from Dakhleh Oasis,’ *The Bioarchaeology of Individuals*. Ed. Ann L.W. Stodder and Ann M. Palkovich, University Press of Florida, Gainesville Florida, pp. 96-112

Tiesler, Vera 1999 ‘Head Shaping and Dental Decoration Among the Ancient Maya: Archaeological and Cultural Aspects.’ Paper presented at the 64 Meeting of the SAA Chicago

--- 2007, “Funerary or Nonfunerary? New References in Identifying Ancient Maya Sacrificial and Postsacrificial Behaviors from Human Assemblages” In *New Perspectives on Human Sacrifice and Ritual Body Treatments in Ancient Maya Society* pp.14-44

---2010, ‘’Olmec’ Head Shapes Among the Preclassic Period Maya and Cultural Meanings,’ *Latin American Antiquity* Vol 21. No. 3 pp. 290-311

---2011, ‘Becoming Maya: Infancy and Upbringing Through the Lens of Pre-Hispanic Head Shaping,’ *Childhood in the Past*, 4: 117-132

---2014a. ‘Cultural Frameworks for Studying Artificial Cranial Modifications: Physical Embodiment, Identity, Age and Gender.’ The Bioarchaeology of Artificial Cranial Modifications. Springer. Pp. 13-32

---2014b. ‘Emulating Olmec Gods Through Head Form. Origins and the Preclassic Period. The Bioarchaeology of Artificial Cranial Modifications, Springer, NY pp. 163-183

---2015. ‘Shifts in Artificial Head forms, Population Movements, and Ethnicity Among the Postclassic Maya,’ *Archaeology and Bioarchaeology of Population movement among the Prehispanic Maya*. Springer. Editor Andrea Cucina pp. 143-154

Tiesler, Vera and Andrea Cucina 2012. ‘Where are the Warriors? Cranial Trauma Patterns and Conflict among the Ancient Maya.’ *The Bioarchaeology of* Violence

Edited by Debra L. Martin, Ryan P. Harrod, and Ventura R. Perez. University of Florida Press pages 160-179

Tiesler, Vera, Andrea Cucina, T. Kam Manahan, T. Douglas Price, Traci Ardren, James H. Burton, 2010. 'A Taphonomic Approach to Late Classic Maya Mortuary Practices at Xuenkal, Yucatan, Mexico.' *Journal of Field Archaeology,* Vol. 35 No. 4 pp. 365- 379

Tourtellot, Gair. Francisco Estrada-Belli, John J. Rose and Normand Hammond 2003. 'Late Classic Maya Heterarchy, Hierarchy and Landscape at La Milpa, Belize,' *Heterarchy, Political Economy, and the Ancient Maya: The Three Rivers Region of the East-Central Yucatan Peninsula* Ed. Vernon L. Scarborough, Fred Valdez Jr. Nicholas Dunning. pgs. 37-51 The University of Alabama Press

Tozzer, A.M. ed., 1941. *Landa's Relacion de las Cosas de Yucatan: a translation*. Peabody Museum of American Archaeology and Ethnology, Harvard University.

Trotter, M., 1970. 'Estimation of Stature from Intact Long Limb Bones.' *Personal Identification in Mass Disasters*, Ed. TD Stewart Washington DC Smithsonian Institution, National Museum of Natural History

Turner, Bethany L., and George J. Armelagos, 2012. 'Diet, Residential Origin, and Pathology at Machu Picchu, Peru,' *American Journal of Physical Anthropology,* Vol. 149 pp. 71-83

Turner-Walker, G., 2008. 'The chemical and microbial degradation of bones and teeth,' *Advances in human palaeopathology*, pp.3-29.

Tyrrell, Andrew, 2000. 'Skeletal Non-Metric Traits and the Assessment of Inter- and Intra- Population Diversity: Past Problems and Future Potential,' *Human Osteology in Archaeology and Forensic Science*. Ed: Margaret Cox and Simon Mays, Greenwich Medical Media Ltd. pp. 289-306

Ubelaker, D.H. 1989. *Human Skeletal Remains. Excavation, Analysis, Interpretation* (3rd ed. 2008). Washington, DC. Smithsonian Institution.

---1992. Porotic hyperostosis in prehistoric Ecuador. *Diet, demography, and disease: changing perspectives on anemia. Nueva York: Aldine de Gruyter*, pp.201-217.

--- 2003. 'Anthropological perspectives on the study of ancient disease.' *Emerging Pathogens: Archaeology, Ecology & Evolution of Infectious Disease.* Eds. Charles Greenblatt and Mark Spigelman, Oxford University Press. pp. 93-103.

Van den Notelaer, Dominick, 2014. *Chan Cahal: Socio-economic dynamics in an agrarian Maya Community in the Blue Creek polity, Northwestern Belize.* MA Thesis. Vrije Universiteit Brussel

Vance, Shannon 2014. *Porotic Hyperostosis and Linear Enamel Hypoplasia as Indicators of health for the Ancient Maya of K'axob, Belize.* MA Thesis. University of Houston, Houston Texas

Versiani, M.A., Sousa-Neto, M.D. and Pécora, J.D., 2011. 'Pulp pathosis in inlayed teeth of the ancient Mayas: a microcomputed tomography study.' *International endodontic journal*, *44*(11), pp.1000-1004.

Wadsworth, G.R., 1992. 'Physiological, pathological and dietary influences on the hemoglobin level.' *Diet, demography and disease: changing perspectives on anemia. New York: Aldine de Gruyter. p*, pp.63-104.

Wagner, Elisabeth 2004. 'Ranked Spaces, Ranked Identities: A View from Late Classic Copán on Local Hierarchies, Community Boundaries, and the Question of an Emic Notion of the Maya Cultural Sphere,' *WAYEB European Association of Mayanists, Ninth European Maya Conference* Bonn, December 10-12 2004.

Wagner, Henry Raup, and Helen Rand Parish, 1967. *The Life and Writings of Bartolome de las Casas*. University of New Mexico Press, New Mexico

Waldron Tony, 1994. *Counting the Dead: The Epidemiology of Skeletal Populations*. John Wiley & Sons Ltd. West Sussex, England

--- 2001. *Shadows in the soil: human bones and archaeology*. Tempus Pub Limited. United Kingdom.

---2007. *Paleoepidemiology: the measure of disease in the human past*. Left Coast Press Inc. California

---2009. *Paleopathology*. Cambridge University Press. New York, NY
Walker, Philip 2005. 'Greater Sciatic Notch Morphology: Sex, Age, and Population Differences.' *American Journal of Physical Anthropology.* 127:385-391.

---2008. 'Sexing Skulls Using Discriminant Function Analysis of Visually Assessed Traits.' *American Journal of Physical Anthropology* 136 pp.39-50

Walker, Phillip L., Rhonda R. Bathurst, Rebecca Richman, Thor Gjerdrum and Valerie A. Andrushko, 2009. 'The Causes of Porotic Hyperostosis and Cribra Orbitalia: A Reappraisal of the Iron-Deficiency-Anemia Hypothesis.' *American Journal of Physical Anthropology*. 139, pp. 109-125

Walker, P.L., 1986. Porotic hyperostosis in a marine-dependent California Indian population. *American Journal of Physical Anthropology*, *69*(3), pp.345-354.

Walper, Ulrike, Eric Crubezy and Micheal Schultz, 2004. 'Is Cribra Orbitalia Synonymous With Anemia? Analysis and Interpretation of Cranial Pathology in Sudan,' *American Journal of Physical Anthropology* Vol. 123 pp. 333-339

Walrath Dana E., Paul Turner, and Jaroslav Bruzek 2004. 'Reliability Test of the Visual Assessment of Cranial Traits for Sex Determination,' *American Journal of Physical Anthropology* Vol. 125 pp. 132-137

Wanner, Isabel S., Thelma Sierra Sosa, Kurt W. Alt, and Vera Tiesler Blos, 2007. 'Lifestyle, Occupation, and Whole Bone Morphology of the Pre-Hispanic Maya Coastal Population from Xcambo, Yucatan, Mexico,' *International Journal of Osteoarchaeology.* Vol 17 pp. 253-268

Warden, Robert, 2010. 'The Center for Heritage Conservation Blue Creek project Preliminary Report,' *The 2009 Season of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize. Ed. Thomas H. Guderjan pp. 189-208

---2012. 'Practical Recording Issues at Small and Large Sales In Maya Archaeology In Belize,' *The 20th annual report of the Blue Creek Archaeological Project*. Submitted to the Institute of Archaeology National Institute of Culture and History, Belmopan, Belize, Ed. Thomas H. Guderjan and C. Colleen Hanratty pp. 271-284

Weaver D.S., 1998. 'Osteoporosis in the bioarchaeology.' *Sex and Gender in Paleopathological Perspective*, p.27.

Watson, James T., 2008. 'Changes in Food Processing and Occlusal Dental Wear During the Early Agricultural Period in Northwest Mexico,' *American Journal of Physical Anthropology,* Vol. 135 pp. 92-99

Webb, S., 1984. 'Intensification, population and social change in southeastern Australia: the skeletal evidence,' *Aboriginal History*, pp.154-172.

Webster, David 1997. 'Studying Maya Burials', *Bones of the Maya*. Ed. Stephen L. Whittington and David M. Reed Smithsonian Intuition Press, Washington pp. 3-12

--- 2000. 'The not so peaceful civilization: A review of Maya war.' *Journal of World Prehistory*, *14*(1), pp.65-119.

---2006. The mystique of the ancient Maya. *Archaeological Fantasies: How Pseudoarchaeology Misrepresents the Past and Misleads the Public, Routledge, London*, pp.129-153.

Webster, David, AnnCorrine Freter and Nancy Gonlin, 2000. *Copán: The Rise and Fall of an Ancient Maya Kingdom.* Wadsworth-Thompson Learning, Bellmont CA

Weiss, Pamela, 1996. 'Continuing Excavations at Structure 4,' ' *Archaeological Research at Blue Creek Belize, Progress Report of the Fourth (1995) Field Season*. Ed. Thomas H. Guderjan, W. David Driver, and Helen R. Haines pp. 37-42

Welsh, W.B.M., 1988. *An analysis of classic lowland Maya burials* (Vol. 409). British Archaeological Association.

West, Georgia, 2002. 'Ceramic Exchange in the Late Classic and Postclassic Maya Lowlands: A Diachronic Approach.' Eds. Marilyn Masson and David Freidel, AltaMira Press, Walnut Creek CA pp. 140-196

Weston, Diane, 2008. 'Investigating the Specificity of Periosteal Reactions in Pathology Museum Specimens.' *American Journal of Physical Anthropology* 137: 48-59

West, R.C., 1964. The natural regions of Middle America. *Handbook of Middle American Indians*, *1*, pp.363-383.

Whitaker, Katie, 2011. 'Anemia Among Past Populations: When Will We Have the Answer?' *Totem: The University of Western Ontario Journal of Anthropology*. Vol. 13 Issue 1 pg. 14-19

White, Christine 1996, 'Structural Effects of Fronto-Occipital Cranial Modification,' *American Journal of Physical Anthropology* 100:397-410

---1997. Ancient diet at Lamanai and Pacbitun: Implications for the ecological model of collapse. Bones of the Maya: Studies of Ancient Skeletons. S.L Whittington and D. M. Reed. Smithsonian Institution Press, Washington DC, pp. 171-180.

--- 1999. *Reconstructing Ancient Maya Diet*. University of Utah Press, Salt Lake City

---2005. Gendered food behaviour among the Maya Time, place, status and ritual. *Journal of Social Archaeology*, *5*(3), pp.356-382.

White, Christine D., and Henry P. Schwartz, 1989. 'Ancient Maya Diet: As Inferred from Isotopic and Elemental Analysis of Bone.' *Journal of Archaeological Science* 16*:* 451-474

White Christine D., Paul Healy, and Henry P. Schwarcz, 1993. 'Intensive Agriculture, Social Status, and Maya Diet at Pacbitun, Belize.' *Journal of Anthropological Research* 49: 347-375.

White, C.D., Longstaffe, F.J., Pendergast, D.M. and Maxwell, J., 2009. 'Cultural embodiment and the enigmatic identity of the lovers from Lamanai.'

Bioarchaeology and Identity in the Americas, Knudson KJ, Stojanowski CM University Press of Florida: Tallahassee, pp.155-176.

White, Christine D., Mary E. Pohl, Henry P. Schwarcz and Fred J. Longstaff 2001 'Isotopic Evidence for Maya patterns of deer and dog use at Preclassic Colha,' Journal of Archaeological Science, 28(1) pp. 89-107

White, Christine D., David M. Pendergast, Fred J. Longstaffe, and Kimberly R. Law, 2001. 'Social Complexity and Food Systems at Altun Ha, Belize: The Isotopic Evidence,' *Latin American Antiquity* 12(4) 371-393

White Christine D., Lori E. Wright, and David M. Pendergast, 1994. 'Biological Disruption in the Early Colonial Period at Lamanai,' *In the Wake of Contact: Biological Responses to Conquest* Ed. Clark Spencer Larsen and George Milner WileyLiss, New York pp. 135-145

White, Tim D., Michael T. Black and Pieter A. Folkens 2012. *Human Osteology*. Academic Press, Elsevier Inc.

White, Tim D. and Peter A. Folkens, 2005. *The Human Bone Manual*. Cambridge University Press. New York, NY

Whittington, Steven L. 1999. 'Caries and Antemortem Tooth Loss at Copán: Implications for a Commoner Diet.' *Reconstructing Ancient Maya Diet* Ed. Christine D. White Univeristy of Utah Press Salt Lake City pp. 151-168

Whittington, Steven L. and David M. Reed, 1997. 'Commoner Diet at Copán: Insights from Stable Isotopes and Porotic Hyperostosis,' *Bones of the Maya* Ed. Stephen L. Whittington and David M. Reed Smithsonian Institution Press, Washington D.C. pp. 157-170

Wilk, R. R., and R. Netting, 1984. 'Households: Changing Forms and Functions,' Households: Comparative and Historical Studies of the Domestic Group. Eds. R. Netting, R. Wilk and E. J. Arnold. Berkeley: University of California Press, pp. 1-28.

Wilk, R.R. and Ashmore, W., 1988. *Household and community in the Mesoamerican past*. University of New Mexico Press.

Willey, Gordon R. 1956. 'The Structure of Ancient Maya Society: Evidence from the Southern Lowlands,' *American Anthropologist* New Series Vol. 58 No. 5 pp. 777-782

Williams, Jocelyn S., and Melissa S. Murphy, 2013. 'Living and dying as subjects of the Inca Empire: Adult diet and health at Puruchuco-Huaquerones, Peru,' *Journal of Anthropological Archaeology,* Vol. 32 pp. 165-179

Williams, Jocelyn S., and Christine D. White, 2006, 'Dental Modification in the Postclassic Population from Lamanai, Belize.' *Ancient Mesoamerica*, Vol. 17 pp. 139-151

Williams, Jocelyn S., Christine D. White, and Fred J. Longstaffe, 2009. 'Maya Marine Subsistence: Isotopic Evidence from Marco Gonzalez and San Pedro, Belize.' *Latin American Antiquity* 20(9) pp. 37-56

Williams, P.L., Roger Warwick, Mary Dyson, Lawrence H. Bannister, 1989. *Gray's Anatomy 37th Edition*. Churchill Livingstone, Edinburgh

Wood, James, W., George R. Milner, Henry C. Harpending, Kenneth M. Weiss, 1992, 'The Osteological Paradox: Inferring Prehistoric Heath from Skeletal Samples,' *Current Anthropology*, Vol. 33 No. 4 pp. 343-370.

World Health Organization, 1948. '*Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference*,' New York, 19-22 June, 1946; signed on 22 July 1946 by the representatives of 61 States (Official Records of the World Health Organization, no. 2, p. 100) and entered into force on 7 April 1948.

Wright, Lori E., 1997a. 'Biological Perspectives on the Collapse of the Pasión Maya.' *Ancient Mesoamerica*. Cambridge University Press. Vol. 8 pp. 267-273

---1997b. 'Intertooth Patterns of Hypoplasia Expression: Implications for Childhood Health in the Classic Maya Collapse,' *American Journal of Physical Anthropology* Vol 102. pp. 233-247

--- 2004. 'Osteological Investigations of Ancient Maya Lives,' *Continuities and Changes in Maya Archaeology: Perspectives at the Millennium*, Eds. Golden and Borgstede Routledge, pp. 179-192

--- 2005. 'Identifying immigrants to Tikal, Guatemala: Defining local variability in strontium isotope ratios of human tooth enamel,' *Journal of Archaeological Science,* Vol 32 pp. 555-566

---2006. *Diet, Health, and Status among the Pasión Maya: A Reappraisal of the Collapse*. Vanderbilt Institute of Mesoamerican Archaeology, Arthur Demarest, Series Editor Volume 2. Vanderbilt University Press Nashville TN

---2011. 'Bilateral talipes equinovarus from Tikal, Guatemala,' *International Journal of Paleopathology,* Vol 1. Pp. 55-62

Wright, Lori E., and Francisco Chew, 1998. 'Porotic Hyperostosis and Paleoepidemiology: A Forensic Perspective on Anemia among the Ancient Maya.' *American Anthropologist, New Series.* Vol. 100 No. 4 pp. 924-939

Wright Lori E., and Christine D. White, 1996. 'Human Biology in the Classic Maya Collapse: Evidence from Paleopathology and Paleodiet,' *Journal of World Prehistory.* Vol. 10 No. 2 pp. 147-198

Wright, Lori E. and M.A. Vasquez, 2003. 'Estimating the Length of Incomplete Long Bones: Forensic Standards from Guatemala,' *American Journal of Physical Anthropology 120:*233-251

Wright, Lori E., and Cassady Yoder, 2003. 'Recent Progress in Bioarchaeology: Approaches to the Osteological Paradox,' *Journal of Archaeological Research.* Vol. 11 No. 1 pp. 43-70

Wrobel, Gabriel D. G., 2003. *Metric and Nonmetic Dental Variation Among the Ancient Maya of Northern Belize.* PhD. Dissertation, Indiana University, Bloomington, Indiana

---2012. 'Mortuary Evidence for Maya Political Resistance and Religious Syncretism in Colonial Belize,' *The Bioarchaeology of Individuals*. Ed. Ann L. W. Stodder and Ann. M. Palkovich University Press of Florida, Gainesville Florida, pp. 68-82

APPENDIX A

COMPLETE BURIAL SUMMARIES

Note: any burial numbers not listed in this sequence are due to the remains being deemed faunal rather than human, or are no longer present in the collection. What follows are summaries of all of the burials analysed throughout this research study.

Blue Creek AW Burial 1

Burial BC-AW-1 is in exceedingly poor condition and is highly fragmentary, and is composed of only a few fragments. Because of this, sex could not be determined. Neither could age, other than adult.

Blue Creek AW Burial 2

Like BC-AW-1, Burial BC-AW-2 is also in exceedingly poor condition and is highly fragmentary, and is composed of only a few fragments. Because of this age, other than adult, and sex could not be determined.

Blue Creek AW Burial 3

Burial BC-AW3 is that of an old adult, probable female. Age is based on complete epiphyseal union, all teeth in occlusion, and advanced stages of dental wear. Sex is based on the exceedingly gracile skeletal remains. There skeletal assemblage is represented only by about 100 small fragments, including a number of cranial fragments and the right patella and all of the fragments are poorly preserved. Slight enamel hypoplasia is observed on the labial surface of the left maxillary central incisor, a large cary is noted on the mandibular left third molar along the cevicoenamel line, and an unsided maxillary first molar has three caries on the crown. An unsided maxillary second premolar also has a carious lesion on the cervicoenamel line, on the buccal side. Dental modification is present in the tooth affected by enamel hypoplasia, in Type B4.

Blue Creek AW Burial 4

Burial BC-AW-4 is composed of only a few fragments, is in poor condition, and is highly fragmentary. Burial BC-AW3 represents that of an immature aged 15 +/- 3 years at age-at-death, of indeterminate biological sex. Age was based on the fact that though the crowns of the third molars were present, they were not yet erupted and had no roots whatsoever. However, the individual did have dental modification, both maxillary canines were observed to be in Type C5, suggesting perhaps the older side of the age estimate. Other dentition present was unsided maxillary M1 and P4 are present, one mandibular M3 is erupted and the crown of the other is present. Both mandibular P4s and lateral and central incisors are also present as is an unsided mandibular M1 and C1. Though the dentition is heavily corroded, moderate linear enamel hypoplasia can still be observed on both of those maxillary canines.

Blue Creek AW Burial 5

Burial BC-AW5 is that of an immature between the ages of two to three years at age-at-death, of indeterminate sex. Age was based on a multitude of factors: dental eruption, long bone size, and rates of epiphyseal union. The ossification and dental eruption observed is as follows: the lateral and basio portions of the occipital are not yet fused to the squamous portion, the vertebral lamina are fused together but are not yet fused to the vertebral bodies, finally, though the deciduous first molar has erupted the deciduous second molar is still crypt. Most of the skeletal elements for Burial BC-AW5 are missing, and what remain – dentition, a few cranial fragments, vertebrae, and rib fragments – are in poor to fair condition. Severe porotic hyperostosis can be observed in many of the cranial fragments and severe cribra orbitalia can also be seen in the eye orbits.

Blue Creek AW Burial 6

Burial BC-AW-6 is an adult male, sex was based on a sciatic notch scoring of 5. The burial is highly fragmentary, and only a few skeletal fragments and loose dentition are representative of this individual, mainly in the form of cranial and long bone fragments, as well as a few phalanges and pelvic fragments. All present dentition (an unsided maxillary M1, left M2, right P4 and right I1 and all mandibular first and second premolars and M3s. as well as an unsided mandibular canine and central incisor that exhibits slight dental calculus.

Blue Creek AW Burial 7

Burial BC-AW7 is that of an adult of indeterminate biological sex. Age was based on complete epiphyseal union as well as on dental attrition. In total, the burial is represented by only fifty small fragments of bone and dentition, including cranial and rib fragments, one distal phalanx of the hand, a portion of the glenoid fossa, and a number of unidentified fragments. There are only two teeth present, an unsided maxillary second premolar and upper central incisor, which is modified in Type E1 modification on the Molina System, the inlay itself is absent.

Blue Creek AW Burial 8

Burial BC-AW8 is that of an adult male between the ages of 30 and 40. Age estimation was based on complete ossification, advanced stages of dental wear, in between stages F and G, and the symphyseal face of the left pubic symphysis, which was in stage 5. Sex was determined based on a mental eminence score of 5 (hyper-male), mastoid process score of 4, gonial angle score of 5, and a think sub-pubic ramus. Measurements were taken on the femoral head, which measured 43mm wide. Preservation of the remains was observed to be poor to fair, and they were highly fragmentary. A large cavity was observed on the buccal surface of the mandibular left third molar, and slight osteophytic lipping was observed on a number of the thoracic vertebrae. The individual also suffered a healed fracture in the right ulna. The individual practiced dental modification in the form of Molina Type B4 on both of the maxillary central incisors.

Blue Cree AW Burial 9

Burial BC-AW-9 is in exceedingly poor condition and is highly fragmentary, consisting of only a few fragments. Because of this age, other than adult, and sex could not be determined.

Blue Creek AW Burial 10

This burial was only a few fragments and the remains were in poor condition; however, with what was available, age at death was estimated to be old adult and sex was estimated as male.

Blue Creek AW Burial 11

Burial BC-AW-9 is in exceedingly poor condition and is highly fragmentary, consisting of only a few fragments. Because of this age, other than adult, and sex could not be determined.

Blue Creek AW Burial 12

The skeletal assemblage of Burial BC-AW12 is in very poor condition and is also highly fragmented, primarily composed of long bone and cranial fragments, and various vertebral lamina and phalanges. The most complete bone represented is the left ulna, at about 80% present. Because most of the skeletal elements are missing and what remains is in such poor condition, sex and age, apart from general adult, could not be determined. The individual of Burial BC-AW12 practiced dental modifications in various forms. The maxillary central incisor is modified in a type which does not fit into the Molina System, and the lateral maxillary incisor is in Type A4. There is also possible cranial modification, however, the cranial pieces were too few and too fragmentary to be absolutely certain.

Blue Creek AW Burial 10E60

Biological sex for Burial BC-AW-10E60 could not be determined. Age was estimated as middle adult, based on moderate dental attrition, stage F, and complete epiphyseal union and dental occlusion. Overall preservation was poor and the remains were highly fragmentary. Slight linear enamel hypoplasia was noted on a maxillary central incisor and lateral incisor along the labial surfaces.

Blue Creek AW 10F36

Burial BC-AW 10F36 is composed of only twenty bone fragments. As such no diagnostic material was recovered so a biological profile could not be determined.

Blue Creek BV Burial 1

This burial consisted only of about forty small fragments, primarily of long bone, however it was discernable that the individual was an adult female. However, no other diagnostics could be ascertained.

Blue Creek BV- Burial 2

Burial BC-BV2 is an adult possible male, based on a mastoid process score of 4. Only a few fragments represent the skeletal material present, composed of a fragment of mandible, 20% of an unsided humeral diaphysis, and about 40% of the cranium, which included most of the frontal bone. The surviving frontal exhibits slight porotic hyperostosis, as does a fragment of the temporal. There is also evidence of cranial modification on the temporal, in the form of a straight line bisecting the temporal. The individual was interred with the head to the south, in a flexed position, and the burial is dated to the Late Terminal Classic.

Blue Creek BV Burial 3

Age, other than 'adult,' and sex could not be determined for BC-BV-3. The skeletal remains were exceedingly fragmentary, and consisted only of fragments of the cranium, left humerus, femur and about 30% of the mandible.

Blue Creek BV Burial 4

Burial BC-BV-4 is in exceedingly poor condition and is highly fragmentary, consisting of only a few fragments. Because of this age, other than adult, and sex could not be determined.

Blue Creek Burial 1

Excavated from within Structure 1 at the Blue Creek site core, BC-1 consists of only a few bone fragments. As such neither age at death nor sex could be determined.

Blue Creek Burial 2

Burial BC-2 was estimated to be a middle adult at age at death, and of indeterminate biological sex. The burial consisted of only a few fragments and was excavated in a crypt burial within Structure Nine of the Blue Creek site core.

Blue Creek Burial 3

The age at death of BC-3 is estimated to be adult while sex is probable female, with a sciatic notch scoring between 1 and 2. The remains present consist largely of cranial and long bone fragments as well as pelvic fragments. There is rodent damage to many of the cranial fragments, despite this however, slight cribra orbitalia was observed in the right eye orbit. This burial was excavated in Tomb Four of Structure One at the Blue Creek site core.

Blue Creek Burial 4

Apart from one lamina of one vertebra all of burial 4 is literally bone dust and therefore age at death and sex could not be determined.

Blue Creek Burial 5

Burial BC5 is that of a male between the ages of 30 and 50 at age-at-death. Sex estimate is based on a mastoid process score of 4 and a sciatic notch score also of 4. Age estimate is based on complete epiphyseal union, and the symphseal surface of the pubic bone. Because of a complete lack of osteophytic lipping on the remaining vertebral fragments, it is possible that the individual's age falls to the younger end of that estimate. The femoral head measures 42.28 wide. The individual had a healed fracture on the proximal end of the diaphysis of the right radius. The interment itself was an intrusive burial near the northern wall of Room B, Structure 9. It was 48cm underneath the floor, marked by a cut circular outline in the limestone plaster floor. The individual was buried in a tightly flexed position with the head facing towards the east. No grave goods were found in association with this burial.

Blue Creek Burial 6A

The individual of Burial BC6A is an immature of indeterminate biological sex, aged between 8 and 11 years at age-at-death. Age was based on Shafer and Black's methods for measuring long bone diaphysis to estimate age-at-death of immatures. Both the left radius and tibia seem to exhibit slight bowing, likely caused by malnutrition of some kind. The individual was interred, along with Burial BC6B, in a cyst burial in the bedrock (Lichtenstien 1995). Excavated in Structure 9 at the Blue Creek site core.

Blue Creek Burial 6B

Burial BC6B is an adult of indeterminate biological sex. The preservation of the remains is fair, however they are encased in a thin layer of limestone plaster thus making any analysis of the cortical bone unattainable. Not much of the skeleton is present, only fragments of long bone. The right humerus has a healed fracture and, as with Burial BC6A, slight bowing can be seen in the right tibia. Excavated in Structure 9 at the Blue Creek site core.

Blue Creek Burial 7

Burial BC-2 was estimated to be a middle adult at age at death, and of indeterminate biological sex. The burial consisted of only a few fragments and was excavated in Structure 9 of the Blue Creek site core.

Blue Creek Burial 8

Burial BC8 is that of a middle to older adult female. Age estimate is based on complete epiphyseal union, and the presence of slight osteophyitic lipping on T-5, T-8, T-9, and T-12. Sex is estimated as female based on a sciatic notch score between 1 and 2, and a mastoid score of 2. The skeletal remains are in good condition and approximately 95% of the skeleton is present, including one incus bone (a few rib fragments, carpels and phalanges are absent from the photograph). The proximal end, just distally of the neck, of the left radial diaphysis has a healed fracture. Measurements were taken of the right ulna, which measures 9.25cm in length and the right femur, with a femoral length of 33cm. Slight porotic hyperostosis is present on the left temporal, though it is possible that these small porosities are taphonomic in nature. While no cranial modification was observed the original site report (Lichtenstein 1997: 45) states that the individual's dentition was modified, and a number of teeth also had carious lesions, stating that 'dental mutilation was present on the upper right lateral incisor and canine as well as the upper left canine. Caries were observed in the upper right canine, the upper left second molar, and lower left canine, first premolar' (Lichtenstein 1997: 45) However the teeth are no longer with the remains and so could not be included in this analysis. The interment itself was located in a western bench of Room F, Structure 19 The individual was buried in an extended position, on the left side (Lichtenstein 1997: 45). Preservation of the skeletal assemblage was excellent.

Blue Creek Burial 9

The individual of Burial BC9 is that of a middle adult male, likely over the age of 35. Sex is based on the angle of the ascending ramus, and the mental eminence score. Age is based on complete epiphyseal union and slight osteophytic lipping of one thoracic. Ulnar physiological length measures 21cm. The individual practiced dental modification, as the maxillary left canine is in Type B5, the maxillary central incisor is in Type A2. A large cavity was present on the mandibular right second molar. Finally, periodontal disease can be observed on the mandible. According to Lichtenstein (1997: 45) the individual was buried in an east-west orientation, with a broken obsidian blade.

Blue Creek Burial 10a

Burial BC10A is highly fragmentary and the bones which remain are in very poor condition. Based on the cranial fragments it is clear that these are the remains of an immature, however nothing else about this individual can be ascertained. No burial goods were found in association of neither Burial BC10A nor Burial BC10B. Both were exhumed from Structure 19 at the Blue Creek site core

Blue Creek Burial 10b

Burial BC10B is, like Burial BC10A, exceedingly fragmented and in very poor condition. Age is estimated as adult not further specified, and biological sex could not be determined. There is slight lipping on some vertebral fragments. According to Lichtenstein (1997) the individual had modified teeth, in the form of type B4 on the maxillary central incisors, and caries were also noted on the mesial side of the maxillary left central incisor, as well as the labial surface of the maxillary left anterior premolar and the mandibular right first molar. However, the teeth have been removed from the skeletal assemblage and could not be included in this analysis. No burial goods were found in association of neither Burial BC10A nor Burial BC10B. Both were exhumed from Structure 19 of the Blue Creek site core.

Blue Creek Burial 11

Unfortunately, not much can be ascertained from Burial BC11. Neither age for sex could be determined, as only a few fragments of the skeleton remain, namely about 20% of the cranium, and some larger fragments of long bone belonging to the lower limbs. The burial was excavated in Structure 9 at Blue Creek.

Blue Creek Burial 12

Burial BC-12 is in exceedingly poor condition and is highly fragmentary, consisting of only a few fragments. Because of this age, other than adult, and sex could not be determined. The burial was excavated at Structure 19 of the Blue Creek site core.

Blue Creek Burial 16

Like BC-12, Burial BC-16 is in exceedingly poor condition and is highly fragmentary, consisting of only a few fragments. Because of this age, other than adult, and sex could not be determined. The burial was excavated at Structure 9 of the Blue Creek site core.

Blue Creek Burial 17

Although highly fragmentary and in poor condition, BC-17 was estimated to a immature at age at death, though unfortunately a tighter age range could not be determined. As the remains were immature, an estimate of biological sex could not be determined. Burial 17 was located within Structure 9 at the Blue Creek site core.

Blue Creek Burial 20

Very fragmented, only a few fragments present. Partial phalanges and one ulnar shaft. Age at death was estimated only as adult, and sex could not be determined. The burial was excavated from Structure 24 of the Blue Creek site core.

Blue Creek Burial 27

Burial 27 at Blue Creek is very fragmented and totals roughly forty small pieces, mainly of long bone. Based on what is left of the remains, as well as records, Burial BC-27 was immature at age at death. BC-20 was buried within Structure 9 at the site core of Blue Creek.

Blue Creek Burial 31

Very fragmented, only a few fragments present mostly cranial fragments, and no dentition. Age could not be determined other than 'adult' and neither could biological sex.

Blue Creek Burial 32

Despite being exceedingly fragmentary, BC-32 was estimated to be an adult male. Biological sex was based on the mental eminence score of 4. Other than fragments of mandible, other partial skeletal elements present include the partial diaphysis of the femur, cranial fragments, and a few other fragments of long bone. Burial 32 was excavated within Structure 25 at the site core of Blue Creek.

Blue Creek Burial 33A

Age for Burial BC33A could only be analyzed as adult. Biological sex could not be determined. Burial BC33A was heavily comingled with Burial BC33B. The long bones found within the burial as well as what is present of the axil skeleton, have been demarcated as belonging to BC33A, while the cranial fragments, third humerii and several other smaller fragments have been sanctioned as part of the BC33B assemblage. This is due to the vast difference in preservation of the remains from BC33A to those of BC33B as well as the presence of that third humerii, and that the cranial fragments from BC33B are from a much younger individual than that of BC33A. The right femoral head for Burial BC33A measures 39.43mm, while the left measures 42.00mm.

Blue Creek Burial 33B

Burial BC33B was found very comingled with Burial BC33A. BC33B is represented through only cranial fragments, a humeral fragment and a few other small fragments of bone. As stated above, the distinction between the two individuals was found due to the age-at-death difference between the cranial fragments and the majority of the skeletal remains within the burial as well as the presence of a third humerii, and the general overall preservation differences between the two sets of remains. While sex for BC33B could not be determined, age is estimated as an immature.

Blue Creek Burial 34:

Burial BC34 is that of an adult, probable male between the ages of 20 and 35 years old at age-at-death. Age is based on dental wear and complete epiphyseal union, while sex is based on the robust nature of the remains. Slight calculus is present on two of the teeth. The remains are highly fragmentary, and the burial is represented mainly through fragments of cranium, long bone and vertebrae. The talus, calcaneus and cuboid of the right foot are present as is the right patella and a partial scapula fragment. Slight porotic hyperostosis is seen on the cranial fragments. The burial itself is dated to the late Preclassic and was the primary burial in Tomb 5. The burial dates to the late Preclassic to about AD 100/150 to 250 (Guderjan *et al*., 2014). The tomb is located on a hill about 70 meters high, and is roughly 4.25 kilometers to the northeast of the Blue Creek site core (Guderjan *et al*., 2014). Unlike typical tombs with corbeled arches or vaulted ceilings, the architects of this tomb used the natural limestone bedrock formations and dug a chamber into the pre-existing bedrock (Guderjan *et al*., 2014). The burial chamber itself is just over 1 and half meters high and two meters in diameter (Guderjan *et al.,* 2014). Past the sealed limestone slab entranceway and within the burial chamber itself three burials (BC34, BC35 and BC36) were found positioned on top of a layer (measuring 5 to 10cm high) of fish. Being the primary burial of this tomb, BC34, was positioned in an extended supine position with slightly outstretched arms and crossed ankles (Guderjan *et al.,* 2014). Associated grave goods were consisted of twenty-eight ceramic vessels, which had been placed in arrangement surrounded the skeletal remains of BC34 and jade, obsidian, copal and hematite were also found in association with this burial (Guderjan *et al.,* 2014). 28 jade beads and 27 additional beads completed a necklace found around the area of the cervical vertebrae and powdered hematite lightly covered the entire skeleton (Guderjan *et al.,* 2014).

Blue Creek Burial 35

Burial BC35 is estimated to be an adult male individual between the ages of 30 and 40 at age-at-death. Age estimate is based on the articular surface of the ilium, as well as the slight lipping noted on the body of the thoracic vertebrae. Sex was based on the robust bones, as well as the left illiopubic ramus and finally a mental eminence score of 4. Measurements of the femoral heads were taken with the right femoral head measuring 46mm and the left measuring 43.32mm. Slight indicators of Cribra Orbitalia were observed in both eye orbits, particularly the right orbit, and a healed fracture of the right fourth metatarsal. The burial itself was excavated in Tomb 5 of Structure 1in the Blue Creek site core. The burial dates to the late Preclassic to about AD 100/150 to 250 (Guderjan et al 2014). Burial BC35 was found at the feet of the primary burial, BC34, in a tightly flexed position with the head to the northeast (Guderjan et al 2014). Associated grave goods for BC35 are seven jade beads, which appear similar in style to the jade beads found in association with BC34 (Guderjan et al 2014).

Blue Creek Burial 36

Burial BC36 was, like BC34 and BC35 located within the burial chamber of Tomb 5 at Blue Creek. The burial was found placed within three separate ceramic vessels (artefact numbers BC 5713, 5717, 5723) found at the left hand of BC34, the primary individual of the tomb (Guderjan et al 2014, Telepak pers. comm. 2014). While cranial remains were not recovered within this assemblage, the skeletal remains which were discovered include vertebrae, clavicle ribs, ulnae, phalanges, sacrum and coccyx (Guderjan et al 2014). It is possible that the remains are from two separate individuals based on the apparent age-at-death differences in the vertebrae and clavicle (Guderjan et al 2014); however, as the remains are no longer present at the basecamp this author was unable to corroborate those findings.

Blue Creek Burial 38

These skeletal remains are highly fragmented and consist largely of cranium fragments. Age was estimated to be middle adult, and biological sex of the individual could not be determined. Slight porotic hyperostosis was noted on a few of the frontal fragments.

Blue Creek Burial 39

Located within Structure 48, BC-39 consists only of about sixty extremely small fragments, most no larger than a few centimeters. Age could only be designated as ‘adult’ and sex could not be determined. No dentition was present.

Blue Creek Burial 40

BC-40 consists only of approximately forty fragments of bone, all only about a centimeter in size. Because of this only age could be determined as 'adult,' there was no indication that the remains were immature and sex could not be identified. BC-40 was exhumed from Structure 60 at Blue Creek.

Blue Creek Burial 41

While age, other than adult, and sex could not be estimated for BC-41, various fragments of long bones are present as well as multiple phalanges of the foot, and much of the cranium. Unfortunately, most of what was present of the cranium were partial fragments and therefore not diagnostic for determining biological sex. This individual was interred within Structure 48 at Blue Creek.

Blue Creek 42

Burial BC-42 is in exceedingly poor condition and is highly fragmentary, consisting of only a few fragments. Because of this age, other than adult, and sex could not be determined. The individual was interred in Structure 48 at Blue Creek.

Blue Creek Burial KT-44

Unfortunately, not much can be determined for burial BC44. Age can only listed as adult not further specified and biological sex is also indeterminate. The remains were highly fragmentary and many skeletal elements were found to be missing. About 70% of the cranium is present however, and this includes various dental elements. The right lower third molar is present, as is the lower right second molar and first molar (all three of these molars remain within the dental arcade and each exhibit one small cavity. The left second molar is also present with a cavity, and finally both lower central incisors are present. Though affected by caries, the dentition do not exhibit much wear overall, suggesting perhaps an age of Middle Adult. The burial itself was found within Structure 37, Tomb 7 at Kin Tan in Blue Creek (Guderjan 2009).

Blue Creek Burial KT-45

BC-45 consists only of approximately forty fragments of bone, all only about a centimetre in size. Because of this only age could be determined as 'adult,' there was no indication that the remains were immature, and sex could not be identified. BC-45 was exhumed from within Structure 34 at Kin Tan in Blue Creek. The burial dates to the Terminal Preclassic/Early Classic transition, and associated burial goods included a red slipped plate with a kill-hole along with a small polychrome bowl, a jade bead in the mouth and a jade figurine in the shape of an acrobat (Guderjan 2009).

Blue Creek Burial 47A

Burial BC47A is that of an adult, biological sex is indeterminate. While much of the long bones are present not much else remains of the skeleton aside from for rib fragments and a few fragments of vertebrae and carpels. BC47A was found comingled with Burial BC47B.

Blue Creek Burial 47B

BC47B was found comingled with BC47A. This burial is represented solely by about 50 very poorly preserved and highly fragmented pieces. A partial epiphyseal head in the assemblage appears to be unfused, suggesting the individual was a immature at age-at-death, however nothing else could be determined from the remains.

Blue Creek Burial 48

BC-48 consists only of fragments of humerus and ulna, one fragment of rib, and a possible fragment of fibula. Because of this, sex could not be determined and age could be assigned only as ‘adult.’

Blue Creek Burial 50

Burial BC-50 is in exceedingly poor condition and is highly fragmentary, consisting of only a few fragments. Because of this age, other than adult, and sex could not be determined.

Blue Creek Burial 51

Highly fragmentary, BC-51 is estimated to be an immature due to the thin occipital fragments and size of the long bone fragments (radius, ulna and humerus), there are also five fragments of vertebrae present and three phalanges. Biological sex is unknown.

Blue Creek Burial 52

There is a note in the bag that reads, “remains were recovered in centerline trench – majority of material was not excavated due to time constraints.” All that are present are roughly 20 small fragments of long bone.

Blue Creek Burial 53

BC-53 consists of only roughly 90 fragments, mostly long bone and cranial, all are about the size of a centimeter and none were diagnostic for biological sex. Age was estimated to be adult.

Blue Creek Burial 54

The age at death for BC-54 was estimated to be middle adult based on clavicle ossification and dental wear. Biological sex could not be determined, though there were a couple of cranial elements present that could have been diagnostic, they were scored at 3s. Skeletal preservation was fair. BC-54 suffered from a healed fracture of the right ascending ramus of the mandible.

Blue Creek Burial 55

Based on a mastoid score of 4, BC-55 is considered to be a male adult. Much of the cranium is present, as well as a partial left calcaneus. No dentition was recovered in association with the remains. The individual was interred within Structure 83 at Blue Creek.

Blue Creek Burial 56

Burial BC56 is that of an adult female. Age was based on complete epiphyseal union, while biological sex was based on a mastoid process score of 1 (hyper-female), and sciatic notch score of 2. The skeletal elements present are mainly cranial fragments, although a few phalanges of the hands and feet are present, as are a few long bone and pelvic fragments. The remains are in fair condition.

Blue Creek Cache 2

Only roughly 10 extremely small cranial fragments in very poor and frail condition, and a few dental elements are representative of Burial BC-Cache2. Biological sex is indeterminate. Age-at-death is estimated at about 18 months +/- 6 months skeletal age based on combined dental and skeletal age estimates. The remains were part of a burial cache within Structure 9 of the Blue Creek site core.

Blue Creek KT- J-14A

Burial BC-KTJ-14A is that of an immature aged four, based on the distal epiphysis and the proximal distal epiphysis of the radius, as well as the ossification rates of the vertebral bodies and the dental eruption rates. BCJ-14A was found in a mass burial along with four other individuals, making the burial of five in total in a chultun context in the proximity of Structure B at Kin Tan (Hanratty pers. comm. 2014).

Blue Creek KT- J-14B

Burial BC-K-J-14B is estimated to be an adolescent, aged between fifteen and seventeen years old at age-at-death. Age is based on ossification rates as well as rates of dental eruption and the presence of an unerrupted left mandibular third molar *in situ*. Though young, biological sex is estimated to be probable male due to the robust bones even at this young age. Also, aside from BCJ-14A, which is too young to determine biological sex, all other individuals buried within this particular chultun burial were determined to be male, and while that indeed does not make BCj-14B male simply by association, the probability of BCJ-14B also being male is high.

Blue Creek KT-J-14C

Individual BC-KT-J-14C is estimated to be an older adult male. Age is based on slight osteophytic lipping on the vertebrae and sacrum, as well as the presence of slight alveolar reabsorption. Sex is estimated as possible male, though somewhat ambiguous as the mastoid process was scored at 3.

Blue Creek KT-J-14D

Burial BC-KT-J-17D is that of an adult male between the ages of 25 and 45. Age estimate is based on dental wear and complete epiphyseal union. Sex is estimated based on a sciatic notch score between 4 and 5 and a mastoid process score also between 4 and 5. This individual was the largest and most robust of the BC-KT-J-14 burial assemblage.

Blue Creek KT-J-14E

The individual represented by Burial BC-KT-J-14E is estimated to be an adult between the ages of 25 and 45 based on dental wear as well as complete epiphyseal union and an absence of any signs of osteophytic lipping on any skeletal elements. Biological sex is estimated as male based on a mental eminence score of 4 and the general size and robust nature of the bones. A sternal foreman was recorded in the burial assemblage, however it is unclear if the sternum belonged to BC-KT-J-14C, D, or E.

Blue Creek KT-J-14

Burial BC-KT-J-14 is an adult male. Age is based on rates of ossification, while sex is based on robust bones and a mastoid process score falling between a 4 and 5 on the Buikstra Ubelaker scale. Most of the skeletal elements are missing, and the skeleton is represented mainly through cranial and long bone fragments, along with various bones of the left foot. The sacrum and right acetabulum are also present. Calculus is present along the cervicoenamel line of maxillary right central incisor, however the remaining dentition (both the maxillary lateral incisors, both canines and first premolars and the mandibular first premolars on both sides, the later incisors on both sides) appear to be in good health.

Blue Creek-RG- 65

Most of the skeletal assemblage for Burial BC65-R1102 is not present, however a general age of adult was determined as was the biological sex being male. Age was based on complete union of the epiphyseal ends, and sex was based on a mastoid process score of 4. The burial itself was located in an intrusive pit burial within Structure R-4 (Preston and Guderjan 2012) .The head was to the west and the individual was interred in a reversed flexed position (Preston and Guderjan 2012). An Ashote Black ceramic vessel with a kill hole was found in association with the remains, and had been placed directly over the cranium (Preston and Guderjan 2012). The cranium and the bones of the left hand were found under a cut in the floor underneath the rest of the skeleton (Preston and Guderjan 2012) and it remains unclear if the amputation of the hand and cranium occurred peri- or postmortem. Finding decapitated remains in reverse flex is a well documented form of Maya sacrifice (Preston and Guderjan 2012), however if this is the case with this set Preston and Guderjan 2012). BC-AM-65 was excavated within the Akab Muklil group of Blue Creek.

Blue Creek Burial Blue Creek Sayap'Ha-1

This burial from Structure 7 at Sayap 'Ha is represented only by seven dentitions (five maxillary and two mandibular), all of which are too corroded to determine any health or age estimate other than middle to older adult.

Blue Creek Burial Sayap'Ha-2

Burial BC-SH-2 is that of an adult of indeterminate sex between the ages of 25 and 30 at age-at-death. The skeleton is represented by approximately 60 small fragments mostly of cranial and long bone fragments, though many of the hand bones and a few of the bones of the foot are also present. Dentition exhibits little wear, though both cavities and LEH are seen in a number of teeth (the right maxillary lateral incisor and first premolar and first molar on the same side all have LEH and the first molar also has a small cavity, the left maxillary lateral incisor and canine also exhibit LEH, the left mandibular first premolar has light LEH and the right mandibular central incisor, canine and first and second molars all exhibit LEH as well, while the lateral incisor on that side also has moderate calculus build up). The individual was buried within Structure 7 at Sayap' Ha.

Blue Creek Burial Sayap'Ha-3

This burial is highly fragmentary, and poorly preserved, with only approximately 100 small fragments surviving, along with a couple teeth (maxillary central incisor, both maxillary second premolars, a maxillary first molar, and a mandibular unsided second molar and mandibular central incisors and canines). As such age, apart from adult based on dentition, and sex could not be ascertained. The maxillary central incisor has severe LEH, however this was the only diagnostic feature for this set of remains. The individual was buried at Sayap' Ha.

Blue Creek Burial CC-15

Burial BC-CC-15 consists of only two small fragments, likely of long bone. Enough was present to determine that the remains were human.

Blue Creek Burial CC-18

The remains of BC-CC-15 are highly fragmentary and consist of cranial and long bone fragments. Not enough of the skeletal material was present to estimate biological sex, nor age, other than 'adult.' The individual was interred under Structure U-5 at Chan Cahal.

Blue Creek Burial CC-24

What remains of BC-CC-24 is very fragmented. About 20% of the cranium is present. Very fragmented, many unidentifiable Age was estimated to be young adult to middle adult, and biological sex could not be determined. The individual was interred within Structure U2 at Chan Cahal.

Blue Creek Burial CC-25

The skeletal remains of this burial are highly fragmented, roughly 80 very small pieces of bone, much of which was mandible. Age was estimated as adult, and sex could not be determined. The individual was interred in Structure U-19 of Chan Cahal.

Blue Creek CC-26

This burial is very fragmented and is composed of only roughly 150 fragments in exceedingly poor preservation. An unsided mandibular central incisor is present exhibited heavy calculus but this is the only skeletal indicator present within this assemblage. The age and sex of the individual could not be determined. The remains were interred within Structure U2 at Chan Cahal.

Blue Creek Burial CC-28

Aside from a few fragments of the right tibia, upper limbs and cranial fragments are all that remains of Burial BC-CC-28. Judging from the cranial fragments, cranial modification is present in the form of fronto-occipital flattening. Age other than 'adult' is not known, and biological sex could not be determined.

Blue Creek Burial CC-29

This burial from Chan Cahal is highly fragmentary, unidentifiable and not diagnostic. Age was estimated as adult, however nothing else could be determined from these remains.

Burial BC-CC-30

Burial BC-CC-30 consists only of about fifty fragments, including cranial fragments and age was estimated as adult. Sex could not be determined. The individual was interred within Structure U2 at Chan Cahal.

Blue Creek Burial CC-47

Blue Creek Burial CC-47 is that of a young adult female. Biological sex estimate was based on the very gracile nature of the remains, as well as a sciatic notch score of 2. The mastoid score was a 3. The individual suffered a healed fracture of the right distal first phalanx of the hand.

Blue Creek Burial CC-49

This burial consists of only a few fragments. However, a note paced within the burial box of BC-CC-47 reads, “Intact B-49 is still in the ground under U-5.” Upon completing the analysis of all of the burials housed at the Maya Research Program, I was unable to locate any further remains belonging to this individual. Also when crosschecking my data with the site reports I was unable to ascertain any further information regarding this particular burial. Therefore I believe that perhaps it was left intact in the burial for later exhumation but such excavation never occurred.

Blue Creek Burial CC-H

BC-CC-H consists only of extremely small fragments (roughly 30) all about the size of a centimeter. Age was established as adult, biological sex unknown. The individual was interred within Structure U-49 at Chan Cahal.

Blue Creek Burial CC-G

BC-CC-H consists only of extremely small fragments mostly of long bone. Age was established as adult, biological sex unknown. The individual was interred within Structure U-9 at Chan Cahal.

Blue Creek CC Burial N

BC-CC-N consists solely of only one fragment of scapula. Age and sex could not be determined. The individual was buried within Structure U-9 at Chan Cahal.

Blue Creek CC Burial K

BC-CC-K consists only of one bone fragment about a centimeter in length. Age and sex could not be established, though it was determined that the remains were human and not faunal.

Blue Creek Burial M

BC-CC-M is solely composed of two small fragments of trabecular bone, like BC-CC-K Age and sex could not be established, though it was determined that the remains were human and not faunal.

Blue Creek Burial CC-J

Three tiny fragments likely long bone. Excavated within Structure U-52 at Chan Cahal. Age and sex could not be determined.

Blue Creek Burial CC-L

Only one fragment small, and one unsided crown of a second premolar.

Blue Creek Burial CC-O

Only two tiny fragments one of which is of a partial phalanx of the hand. The fragments were excavated within Structure U-5 at Chan Cahal.

Blue Creek Burial CC-Q

Vertebral fragments, rib fragment, long bone fragments (humerus and radius) phalanges. Age was estimated as adult, and sex could not be determined. The individual was excavated within Structure 19 of Chan Cahal.

Blue Creek Burial CBN-53

This burial is represented solely by only one phalange, which is highly degraded, and one upper incisor also highly degraded.

Nojol Nah Burial 1

Burial NN1 is an immature between the ages of 10 and 13 at age-at-death likely at the younger end of that scale. Age estimate is based on dental eruption and incomplete ossification, while the proximal epiphysis of the right ulna is indeed fused to the diaphysis the epiphyseal line is still quite pronounced. The radius remains unfused, as are the femoral heads and distal epiphyses of the tibia. The second molar was in the process of erupting when the individual dead, a process which occurs between the ages of 11 and 12. Biological sex could not be determined. Moderate porotic hyperostosis was observed to be present on the occipital. The individual suffered from spina bifida, the only case in the entire known assemblage of not only Nojol Nah but also all three study sites. The spina bifida is evidenced in the sacrum by incomplete closure of the neural arches. The burial itself was an intrusive interment, placed in the cobble fill under the floor of the west building of the plaza known as Barrett's Place, in Structure 4C1. The remains were in a flexed position, facing south. Though many of the skeletal elements are missing the remaining bones are in good condition.

Nojol Nah Burial 2

Burial NN2 is that of a two to three year old individual of unknown biological sex. Burial 2 composes a nearly complete upper skeleton, with upper limbs, scapulae, clavicles, and sternum being represented, along with vertebra and roughly five percent of the mandible present. The overall preservation of the remains is very good. This individual was buried underneath the floor of the south wall of Sub Op G within the ballast fill with no associated grave goods present in the assemblage. Building 4C2.

Nojol Nah Burial 3A

Burial 3A is a possible male roughly 12-15 years old at age of death. This burial is well represented, the bones are well preserved and much of the skeleton is present. The individual represented in Burial 3A suffered from moderate porotic hyperostosis and cribra orbitalia. Also, a number of teeth were affected by enamel hypoplasia, though due to the nature of the mixed assemblage, at times it was not possible to determine if the affected tooth belonged to the individual represented in Burial 3A or that of Burial 3C. Burials NN 3A, NN-3B and NN 3-C were comingled under the floor of Structure 4C6 (Barrett and Brown 2009).

Nojol Nah Burial 3B

NN3B is the burial of an immature of unknown sex. And is poorly represented in the burial assemblage with only the distal end of the humerus being the largest bone fragment representing this burial.

Nojol Nah Burial 3C

NNB3 is of an adult male between the ages of 40 and 55 based on dental wear and the beginning stages of alveolar reabsobtion on the mandible. Burial 3C only consists of a partial right mandible and partial patella.

Nojol Nah Burial 4

The skeletal remains of NN B4 is that of an elderly female. Biological sex was based on a sciatic notch score of 2 to 3 and a mastoid process score of 2. Age-at-death was estimated at or around 60 years, and this estimate was based on dental attrition, heavy alveolar reabsorption of the mandible as well as the presence of heavy osteoarthritis of the vertebral column, particularly L-4 and L-5. Cranial evidence suggests the individual practiced the Olmec style of cranial modification. There is also a large lesion on the posterior distal end of the femoral shaft. Schmorl's nodes are present on L-5, and L-3 has a possible healed fracture on the spinus process. Also of note are the distal and medial phalanges, which exhibit signs of osteoarthritis. Buried in the fill of Structure 4C6 (Barrett and Brown2009). Stature estimated at 4.3 feet tall or 155.615cm.

Nojol Nah Burial 5A

The age-at-death of individual NN B5A is estimated at six and a half years, based on dental eruption rates as well as the absence of permanent dentition. Because the individual died at such as young age, the determination of biological sex was not achievable. The skeleton, though not nearly represented in its entirety, is fairly preserved, and the presence of the deciduous dentition, as well as with rates of ossification, the proposed age-at-death of 6.5 years was reached.

Nojol Nah Burial 5B

Burial NN 5B is that of an older adult of undeterminable sex. The individual is represented primarily though long bones, as both femora and tibiae are present, as well as a partial left ulna and 45% of the left humerus. Age-at-death estimate was reached through the analysis of dental wear, the dentition being very worn. Burials 5A and 5B were comingled in a subfloor pit burial which was dated at belonging to the Early Classic, with no associated grave goods (Barrett and Brown 2009).

Nojol Nah Burial 6

The individual represented in burial NN6 is that of a possible female, age-at-death between 17 and 24. These estimates were based mainly on dental wear, as well as a complete lack of osteoarthritis. The surviving bones appear to be very healthy. Both of the upper lateral incisors are modified in B5 type and the mandibular right second molar has two small cavities. According to Barrett and Brown (2009) the burial was located in the ballast under the floor of 4C6. They also suggest that this was a disarticulated secondary interment, which was also possibly covered by a subfloor capstone and is dated to the Early Classic (Barrett and Brown 2009). Burial NN6 included a small fragment of obsidian, as well as a piece of polished jade (Barrett and Brown 2009). Though much of the skeleton was present, preservation ranged from poor to fair.

Nojol Nah Burial 7

Burial NN7 represents a male adult of about 35-40 years at age-at-death. Sex estimate was reached through a sciatic notch score of 5, mental eminence score of 5 and a supraorbital ridge score between 4 and 5. Age estimate was based on dental together with the presence of moderate arthritis in otherwise fairly healthy looking bones. Skeletal preservation was good, and moderate osteoarthritis is present on the thoracic vertebrae (T3 through T6) as well as on the fourth and fifth lumbar vertebrae. Along with osteoarthritis, the individual represented in burial NN7 also suffered from a well-healed fracture of the right distal tibia along the diaphysis. The individual also suffered from large caries on the mandibular second molars, as well as a small cavity on the right maxillary second and third molars. NN7 had a number of skeletal modifications, both cranial and dental. Though highly fragmentary, the cranium appears to have been modified in possible fronto-occipital flattening. The upper central incisors are both modified in B4 type, while the upper left lateral incisor is modified in C3, the right lateral incisor was not present in the skeletal assemblage. Finally, both upper canines are modified in B5 type. According to Barrett and Brown (2009) Burial NN7 was dated to the Late Classic. Str. 4C6.

Nojol Nah Burial 8

Burial NN8 is that of an immature, age-at-death at about 6 years of unknown sex. While most of the dentition is represented in the skeletal assemblage, overall skeletal preservation is poor and thus photos of NN8 were not taken. The remains were found in a subfloor pit burial which was dated to the Early Classic (Barrett and Brown 2009). Both maxillary deciduous central incisors have small cavities however other than these the teeth seem to be in fair health.

Nojol Nah Burial 9

The individual in Burial NN9 was a female estimated to be between the ages of 50 and 60 years old at age-at-death. Biological sex estimate was based on a mastoid score of 2 as well as a mental eminence score of 2. Age estimate was derived from dental wear as well as the pitting of the pubic symphysis. The skeleton of NN9 is fairly preserved, and most of the skeletal elements are present. The individual suffered from spina bifida. The individual practiced dental modification in the form of a notched lateral incisor in type B4. The interment was found subfloor, along the western wall of 4C6 and was dated to be belonging to the Early Classic (Barrett and Brown 2009). A single shell ordainment was excavated in context with NN7, just underneath the cranium (Barrett and Brown 2009).

Nojol Nah Burial 10A

This burial represents an immature of indeterminate sex who died between the ages of 10 and 13 years old. Age estimate was based on ossification rates of the distal humerus, the proximal epiphyses of the phalanges, the proximal tibia and the distal epiphysis of the metacarpals. The skeletal remains were poorly preserved and much of both the cranium and mandible are missing.

Nojol Nah Burial 10B

Burial 10B is that of an adult and like NN10A biological sex of this individual could not be determined. Age estimate was based on the presence of an unsided mandibular second molar which was not only in occlusion but also exhibits slight signs of wear. The skeleton of NN10B was poorly preserved and most of the skeletal elements are not present. Burials NN10A and NN10B were found comingled in a primary burial within in a bench in Structure 4C6 (Barrett and Brown 2009).

Nojol Nah Burial 11

Burial NN11 represents an immature between the ages of 12 and 14 years of indeterminate biological sex. Age was based on ossification rates of the proximal epiphysis of the humerus, both proximal and distal epiphysis of the radii, fibulae and femora as well as the proximal end of the tibia (the distal end is not present), and the distal epiphysis of the ulna (the proximal end is not present). The crown of the third molar is present in the assemblage, furthering the argument for age-at-death being close to 12 years. The individual in Burial NN11 suffered from a moderate case of cribra orbitalia, in the right eye orbit. The individual was interred under the floor of structure 4C6 and two matching conch sell beads were found in association with this burial (Brown 2009).

Nojol Nah Burial 12A

Interred under a raised floor in Room 1 of Structure 4C6, also referred to as Casa de los Muertos, (Brown 2010) Burial NN12A is that of an adult male older than 35 at age-at-death. Sex estimate was based on a mastoid process score of 5, a sciatic notch score between 4 and 5, as well as the size and robustness of the skeletal remains. Standing between 5.54 and 5.81 feet, this individual was among the largest in stature excavated at Structure 4C6 (Brown 2010). The age estimate was based on dental attrition, complete epiphyseal union, signs of alveolar reabsorption, and the presence of pronounced osteophytic lipping on the lumbar vertebrae. The skeletal remains of Burial NN12A were very well preserved, and the individual practiced cranial modification in the form of fronto-occipital flattening. The individual suffered from caries in six molars.

Nojol Nah Burial 12B

Comingled with Burial NN12A, Burial NN12B represents that of an individual between the ages of 12 and 14 and of unknown sex. Age was based on rates of epiphyseal union. The medial epicondyle of the left distal humerus, was unfused at death, as was the proximal and distal epiphysis of the radius, and the distal femur, metacarpals and metatarsals, and the proximal phalanges and radius. The overall preservation of the skeletal remains of NN12B was fair. Both NN12A and NN12B date to the Late Classic period (Brown 2010). Two small obsidian blades, two polished pendants, and a pendent made from what appears to be a dog’s tooth compose the associated grave goods for these burials (Brown 2010).

Nojol Nah Burial 13

Due to getting wet during excavation, and being damaged by the ballast fill of the burial matrix itself (Brown 2010), Burial NN13 is both very poorly preserved and is not well represented. The individual was an adult, based on ossification and the occlusion of permanent dentition. The individual was a possible female, based on a mastoid score of 2. Burial NN3 practiced both cranial and dental modification, in that there is evidence of fronto-occipital flattening, and the upper left central incisor is notched in B4 type in the Molina system. The burial dates to the Late Classic (Brown 2010) and was devoid of associated grave goods.

Nojol Nah Burial 14

Burial NN14 is that of an adult of indeterminate biological sex. Age estimate is based on epiphyseal union. Much of the skeletal elements are missing, and this burial is represented namely through fragments of long bones. As with Burial NN13, Burial NN14 was also wet during excavation and damaged due to the sharp chert cobble ballast of the subfloor fill. Burial NN14 was interred underneath a bench in Room 2 of 4C6 and was possibly demarcated with a ceramic concentration on the top of the bench (Brown 2010).

Nojol Nah Burial 15A

Burial NN15A is that of an immature between the ages of 2 and 4 years of age at death. Age estimate was based on the rates of epiphyseal union in the skeletal remains which were present, including that the basio-occiptal is also unfused to the occipital condyle and the first cervical vertebra is not yet fused, while most of the vertebral spinus processes are fused together, the processes are not yet ossified to the vertebral bodies. The skeleton is in excellent condition, though there are many missing elements, including about 80 percent of the cranium.

Nojol Nah Burial 15B

Burial NN15A and NN15B were interred in a pit burial. While the orientation of NN15A is unclear, NN15B was laying with the cranium to the south, facing Burial NN16, that of an older adult woman. Burial NN15B was estimated to be a female, based on a mastoid process score of two, glabella score of two as well as a greater sciatic score also of two. Age was estimated between 20 and 30 years of age, based on complete epiphyseal union, and that all dentition was in occlusion, and exhibiting moderate dental wear. However, there is the presence of a not fully erupted upper right third molar, placing the individual likely at the younger end of that scale. Stature for this individual is estimated to have been between 5.16 and 5.43 feet tall.

What remains of the splanchocranium of Burial NN15B, when re-articulated, shows signs of both modification and deformation. Reconstruction also shows asymmetries in facial bones, orbits, mandible, and cranium. Potential mandibular malformation further supported by severe calculus build up on the

maxillary and mandibular left molars (particularly heavy on the upper molars) while the right molars are practically pristine. There left teeth also exhibit more wear than on the right side of the palatine which shows very little wear and no calcification highly suggestive of favoritism of the right side of the mouth. Also on the right side, the unerrupted right maxillary third molar is positioned so the crown in facing posteriorly, towards the cranium and the back of the mouth. Also, the sagittal sulcus does not line up with the palatine split in reconstruction which a 10 to 15 degree difference. Bone behind RM3 (facing posterially) appear to have grown closer to palate than on the left. This may account for the disruption of RM3's growth, as well as caused impaired mastication on the left. The individual also suffered from active non-specific maxillary sinusitis.
Post cranially, the left fibula of NN-15b is bowed slightly. This individual suffered from a large carious lesion on the left mandibular second molar. Finally, this individual practiced dental modification, in that both upper central incisors are notched in B4 and reverse B4, and the left upper lateral incisor is also modified in the B4 style.

Nojol Nah Burial 16

Burial NN16 is that of a possible female, based on mastoid process score of 2 and a mental eminence score of 2. Age-at-death for this individual has been estimated at adult, over forty years of age, due to pronounced alveolar reabsorption, heavy dental wear, and complete epiphyseal union. The individual interred in Burial NN16 had severe tooth decay between the right premolars and heavy calculus was present on many teeth. While not enough of the cranium remained to determine if the individual had undergone cranial modification, NN16 did practice dental modification in the form of B4 on both upper central incisors. The burial was found situated under an earlier construction phase of Room 2, Structure 4C6 and dates to the late classic (Brown 2010).

Nojol Nah Burial 17

Nojol Nah Burial 17 represents a male over the age of 45 years at age-at-death. Biological sex was based on a greater sciatic notch score of 4, a mental eminence score of 5, as well as a mastoid process score of 4. Age was based on slight osteophytic lipping on the phalanges of the hands and feet, as well as moderate lipping on several of the vertebral bodies. Overall preservation of this burial was poor to fair, with not much of the skeleton represented, namely the bones of the hands and feet, various cranial fragments and about 85% of the mandible, a few fragments of rib and pelvic bones and about 70 unidentified small fragments. Dentition however, was well preserved and most of the dental arcade is represented. The dentition is very worn, and there are a number of teeth affected with caries and calculus. Dental modification was present on both of the maxillary central incisors, in B2 type. The interment for NN17 was located just south of Burial NN18 (Brown 2010), which is also likely an older adult male. Both NN17 and NN18 were buried underneath the floor in ballast fill, separated by a large subfloor brick of limestone, a likely burial marker (Brown 2010). No grave goods were found in association with this burial, which dates to the Late Classic (Brown 2010).

Nojol Nah Burial 18

Burial NN18 was analyzed as being a probable male, based on mastoid process score of 4 and a greater sciatic notch score of 5. The individual's age-at-death was estimated at 30 to 40 years of age because all teeth were in occlusion, all bones were ossified, dental wear appears to be quite severe and there is also moderate alveolar reabsorption in the mandible. Much of the skeleton is present, mainly cranial, long bones, ribs and dentition and they were found to be in good condition. One unsided molar has a large cavity. The cranial fragments suggest cranial modification in the form of fronto-occipital flattening. NN18 and NN17 were buried at the same level as NN16 and NN15A and NN15B, at identical elevations, in Room 2 (Brown 2010). Also like NN16, NN15A and NN15B, burials NN17 and NN18 were interred with the individuals facing one another, one head to the south one to the north (Brown 2010). Though estimated to be belonging to the Late Classic, there were no grave goods found in association with Burial NN18 (Brown 2010) which was interred within Structure 4C6.

Nojol Nah Burial 19

Burial NN19 is that of an immature of indeterminate biological sex. Given the small size of the bones, as well as rates of epiphyseal union, age-at-death was estimated to be between the ages of 3 to 5 years. The skeletal remains for this burial were quite poorly preserved, and the burial itself was found in a scatter throughout the easternmost end of subfloor ballast of Room 3, of Structure 4C6 (Brown 2010). Not many of the skeletal elements are represented, namely a few long bone fragments, including the proximal ulna, unfused and 35% of the ulnar diaphysis, 80% of the left femoral shaft, 30% of the right ilium. This burial likely dates to the Late Classic (Brown 2010).

Nojol Nah Burial 20

Burial NN20 is that of an adult female, likely around the age of 40. Sex estimate was based on a mastoid process score of 2, a mental eminence score also of 2, and also that the bones appeared to be very gracile in form. Age was based on dental wear, complete epiphyseal union and that all teeth had erupted and indeed one the lower right third molar had been lost and the alveolar had reabsorbed. However there were no signs of osteophytic lipping on any of the vertebrae. The right second molar has a large cavity, as does an upper canine. There are also five other smaller cavities on five other molars. The skeletal remains for NN20 were found to be in very poor condition, and not many of the bones survive. There were no grave goods found in association with this Late Classic burial.

Nojol Burial 21A

Burials NN21A and NN21B, dated to the Late Classic, were interred underneath the floor, along the northern wall, of Structure 5E1. Both were buried in flexed positions with heads to the south (Brown 2010). NN21A is that of an adult female, over the age of 45 years old at age-at-death. Age was based on dental attrition, as well as the presence of slight osteoarthritis of the medial and proximal phalanges of the hand, and severe osteophytic lipping on a number of vertebrae (L-5, L3, T-12, T-7, T-4 and T-3). Biological sex was based on a mastoid process score of 2, and that the bones themselves appear extremely gracile in nature. Though missing elements, this skeleton is in excellent condition. All of the right and left mandibular premolars have moderate calculus present and the right mandibular second and third molars both have caries. The individual has a congenital sternal foreman, and also practiced skeletal modification, in the form of fronto-occipital flattening (140.69 across widest point, and 139.25 glabella to highest point), and dental modification of the upper central and lateral incisors in type A2 as well as the upper canines in type B7.

Nojol Nah Burial 21B

Burial NN21B is estimated to be an older adult female, over the age of 50. Age estimate was based on dental wear –the dentition is heavily worn – as well the fact that there is complete epiphyseal union, and the presence of osteophytic lipping on many of the vertebrae(severe on L-4, moderate on L-2 , as well as on the left proximal first phalange (severe) and left distal first phalange (severe). The individual also suffered from a healed fracture of the left distal fourth phalange. The left maxillary first premolar has moderate calculus present, however aside from this and heavy tooth wear on all teeth, the dentition otherwise seems to be healthy. The right maxillary central incisor is modified in B4 type. An obsidian blade was found in association with this burial.

Nojol Nah Burial 22

Burial NN22 represents a female likely over the age of 35. Biological sex estimate was based on a greater sciatic notch score of 2, mastoid process score of 1 and supraorbital margin score of 2. Age was based on the auricular surface of the ilium being in phase 4, and the symphyeal face of the pubis being between phases 3 and 4. Age estimates were further supported by dental wear, slight osteophytic lipping on the fourth lumbar vertebra, and that all teeth had erupted. The individual represented in Burial NN22 had a well-healed fracture on the left ulna, beginning at 4.61 cm proximally from the distal end and spanning 3.3 cm. There is also slight bowing anteriorly of the body of the sternum. The teeth suffered from a number of caries, most significantly one molar has three cavities on the crown, while another is almost completely obliterated by a large carious lesion. There is also heavy calculus buildup on along the cervico-enamel line on many of the teeth (right maxillary first molar and left maxillary second molar, right mandibular lateral incisor, second premolar and first molar, and left mandibular second premolar and third molar). There is also moderate alveolar reabsorption of both the maxilla and mandible. The individual of Burial NN22 practiced both cranial modification (fronto-occipital flattening) as well as dental modification (both upper central incisors and canines are in type B4). This was a subfloor interment in the central room of Structure 5E1 and dates to the Late Classic.

Nojol Nah Burial 23

This Late Classic burial is missing most skeletal elements. As such estimate of sex could not be assessed and age estimate was only that the individual was an adult, this is based on ossification rates. The preservation of the skeletal remains, despite the aforementioned missing elements, is poor to fair, and the assemblage mainly consists of hand and foot bones, as well as a few long bone fragments. This individual was interred in a Late Classic pit burial in Structure 5E1 under the floor of the central room (Brown 2010).

Nojol Nah Burial 24

Burial NN24 is estimated to be an adult male. Age was based on the occlusion of the teeth, as well as dental wear, which was moderate. Biological sex was based on a greater sciatic notch score, which fell between 3 and 4, and a mental eminence score of 5. Most of the skeleton is missing, and though the cranium is about 50% present it is highly fragmentary and excludes any diagnostic features relevant to sex. Both upper third molars have moderate calculus, and an upper unsided second premolar also has moderate calculus as well as a small carious lesion on the crown. Though highly fragmented, one of the largest surviving fragments of the skeleton of NN24 is the distal half of the right humerus has a lesion from an infection. The lesion measures 1.6 cm just above and slightly left of where the coronoid fossa should be. NN-24 also had a peg tooth and both maxillary lateral incisors were modified in type A2, as well as in the maxillary central incisor also in type A2 (the corresponding right central incisor was absent from the skeletal assemblage). The interment itself was found subfloor of the central room of Structure 5E1, with the skeleton in a flexed position (Brown 2010). No associated grave goods were found with this Late Classic burial (Brown 2010).

Nojol Nah Burial 25

The individual of Burial NN25 is estimated to be an older adult, probable female, however this estimate of biological sex is based solely on a greater sciatic notch score. The burial was highly fragmentary, and not many of the skeletal remains are present. There is severe osteophytic lipping on L-5 and L-4. What little of the cranium remains appears fairly healthy, with no evidence of porotic hyperostosis or cribra orbitalia. While most of the skeleton is missing, much of the dentition remains, Both of the mandibular second and third molars are present, the mandibular first premolar, both of the maxillary central incisors in type B4 modification, both mandibular canines with severe calculus, both mandibular second premolars and central incisors both with severe calculus, a maxillary first premolar and the left maxillary lateral incisor in reverse B4 type modification, maxillary second premolar, unsided, mandibular right first molar and both upper canines modified in A4 type of modification. The individual also has possible cranial modification, though the cranium is so fragmented and is missing so many elements it is unclear which type of modification was practiced. This burial dates to the Late Classic.

Nojol Nah Burial 26

Burial NN26 is extremely fragmentary and consists mainly of about 200 very small pieces. However, it was determined that the individual was an adult male between the ages of 30 and 40 at age-at-death. This was estimated based on a sciatic notch score of 5, and age was based on dental wear as several teeth are present (cap of lower right second premolar, both lower third molars, lower left first molar, lower left second premolar, both upper canines, both upper central incisors (featuring B4 type modification), both upper lateral incisors an unsided lower central incisor with severe calculus, unsided lower lateral incisor upper first premolar with cavity on the cervicoenemal line, and left mandibular canine. The cranial fragments present consist mainly of frontal pieces and these are covered in a thin layer of red ocher and there is also evidence of cranial modification, though it remains unclear which typology it falls into as so many elements are missing.

Nojol Nah Burial 27

Burial NN27 is that of an immature adolescent, of indeterminate biological sex. Age estimate is based on dental wear, very slight, pattern B-C, as well as rates of ossification, the vertebral lamina remains unfused to the vertebral bodies in an unidentified thoracic vertebra. Preservation of the remains is exceedingly poor and the remains are also highly fragmentary. Of the cranium, only a fragment of zygomatic is present. The burial was discovered within Structure 5E5.

Nojol Nah Burial 28

Burial NN28 is that of an adult female over 45 years of age. Age is based on dental occlusion and complete epiphyseal union, as well as the presences of slight osteophytic lipping on several of the lumbar vertebrae. Sex is estimated as female based on a sciatic notch score of 2. Several rib fragments were found to be dusted in red ochre.

Nojol Nah Burial 29

Burial NN29 is an elderly adult male. Age is based on extreme dental wear, complete epiphyseal union, and alveolar reabsorption in the mandible. Sex is estimated as male based on a mastoid process score of 5 (hyper-male). While the cranium, hands and feet are represented not much else of skeleton remains, instead what is left is about 300 very small highly fragmented pieces. Of the remaining dentition, several teeth have caries: the right maxillary first premolar exhibits a large abscess on the lingual side of the cervicoenemel line, the mandibular right second molar has a large abscess on the cervicoenmel line along the buccual side and an unknown tooth, likely a second premolar, which is exhibits an abscess which obliterates 50% of the enamel, thus making the tooth difficult to correctly identify. The individual practiced dental modification, and as such the maxillary left central incisor is modified in Type B4 on the Molina System.

Nojol Nah Burial 30

Burial NN30 is that of a probable male, based on a mental eminence score of 4, who died when he was an older adult. Age is based on heavy dental wear, and pronounced osteophytic lipping on the bodies of several lumbar vertebrae. The individual interred in Burial NN30 suffered from six cavities. From the twelve recovered teeth it seems that the individual did not practiced any from of dental modification. Cranial fragments also appear to rule out any cranial modification. The burial was a primary interment, with the individual being buried in a flexed position, head to the south, within the west bench of Room 1 Str. 4C10 (Brown 2011). This burial was found directly on top of Burial 32, a crypt burial and there were no associated grave goods found in association with this burial (Brown 2011).

Nojol Nah Burial 31

This burial, NN31 is thought to be that of an adolescent female. Age estimate was based on the partial eruption of the third molars, the development of the symphyseal surface, which was in Phase I (15-24 years of age). Also, although there was complete epiphyseal union, the epiphyseal scars between the sacral bodies are still visible as are the epiphyseal scars on a number of vertebral bodies. Sex was based on a greater sciatic notch score of 2, a mastoid process score of 2, a supraorbital margin score of 1, and a mental eminence score of 2. The skeleton also appears to be very gracile, and though this could be due simply to the young age of the skeleton, the medial aspect of the ischiopubic ramus is very thin and sharp, furthering the conclusion of the skeleton being biologically female. Dental modification was observed in the upper central incisors and upper canines, all in type B4. There is also slight evidence that the occipital was modified, suggesting fronto-occipital flattening of the cranium. This individual was the most well preserved individual to be exhumed during the 2010 field season at Nojol Nah. Height of this individual was estimated to be at about 5.03 feet tall. The interment itself was primary, under the floor of Str. 4C10 in Room 3 (Brown 2011). It is quite possible this was a crypt burial, as there were three large upright cut limestone blocks in a crescent around the burial (Brown 2011). The body was buried in a tightly flexed position with the head facing west (Brown 2011).

Nojol Nah Burial 32

Burial NN32 is that of a young adult of indeterminate biological sex. Age is based on complete epiphyseal union, and the presence of permanent dentition though they hardly exhibit any signs of wear. The burial was very poorly preserved, and most skeletal elements are missing, with only three teeth present, a few fragments of the ribs and long bones. There are however, many vertebral fragments. Due to the relative abundance of the vertebrae, and the lack of smaller bones, it is likely that this was a secondary interment. The interment was found in a small limestone crypt underneath Burial 30, under the floor supporting the western bench in Room 1 of Structure 4C10 (Brown 2011). This interment was buried in the prehistoric A horizon (Brown 2011). Position was not articulated so position of the remains could therefore not be determined (Brown 2011)

Nojol Nah Burial 33

Burial NN33 is very poorly preserved, however age and sex could still be estimated with what little of the skeleton remained and was diagnostic. Based on dental wear age is estimated as adult, and based on a sciatic notch score of 5 (hyper-male) the sex of NN33 has been estimated as male. An unsided mandibular first molar exhibits a cavity on the crown, and is extremely worn. Both mandibular central incisors show heavy calculus, while the maxillary right lateral incisor has slight LEH. The individual practiced dental modification in the form of Type B4 in both of the maxillary central incisors.

Nojol Nah Burial 34

Burial NN34 is a poorly preserved burial of an older adult, estimated to be a probable female. An age of old adult was assigned due to the extreme dental wear, advanced tooth decay, and complete epiphyseal union. Biological sex is thought to be probable female based on a supraorbital margin score of 2, as well as a mental eminence score also of 2. The burial was discovered within the construction fill under the floor of Room 1, Structure 4C10 (Brown 2011). This was a primary burial (thought to be so based on the abundance of teeth and smaller bones, such as phalanges), about 20 centimetres above the prehistoric ground surface in between burials NN33 and NN37 (Brown 2011). The body of the individual of NN34 was buried in a tightly flexed position, head to the south (Brown 2011). No grave goods were found in association with these remains (Brown 2011).

Nojol Nah Burial 35

The individual belonging to burial NN35 was estimated to be that of an adult, probable female. Sex was based on a mastoid process score of 1, and the overall gracile nature of the bones. Age was based on advanced dental wear, and complete epiphyseal union. The skeleton was poorly preserved and most of the skeletal elements are missing. The burial is thought to be a secondary interment (Brown 2011). The interment itself was small square limestone crypt underneath the floor layer of the eastern bench 2 in Room 1 of Structure 4C10 (Brown 2011). Burial goods were composed of two jade ornaments, 19 ceramic sherds, one worked sherd, and a fragment of painted plaster.

Nojol Nah Burial 36

This interment is estimated to the burial of an adult, possible female. Unfortunately a more precise age and sex estimate could not be achieved. Age is based on moderate dental wear and complete epiphyseal union. Sex is based on a greater sciatic notch score of 1, hyper-female, though other elements were missing and so only this one skeletal indicator could be ascertained. Aside from a large carious lesion on an unsided maxillary premolar, there were no pathological indicators present either. The burial itself, was likely secondary, and was a small limestone crypt under east bench 2 of Room 1 4C10, between Burials NN35 and NN37 (Brown 2011). A mano fragment was found within the boundaries of the interment, though it remains unclear if this was indeed a burial good, or simply an inclusion from the construction fill of the floor which filtered down into the burial (Brown 2011).

Nojol Nah Burial 37

This burial is very poorly preserved. The remains are those of a possible female, between the ages of 45 and 55. Sex is based on a mastoid score of 2, while age estimate is based on slight alveolar reabsorption and dental wear. There is possible porotic hyperostosis on a fragment of the frontal bone, and moderate LEH is present on both maxillary canines. Skeletal modification is seen in the form of fronto-occipital flattening, as evidenced on the frontal bone, the maxillary right central incisor is modified in type C4, and both maxillary canines are modified in C5 type.

Nojol Nah Burial 44

This is the burial of a young adult of indeterminate sex. Though preservation of surviving skeletal material is fair, there are numerous skeletal elements missing. Burial NN44 was interred in a crypt within the construction fill of the last architectural phase of Structure 4D2 at Nojol Nah and is likely to be a secondary burial. One upper incisor is notched in type A2. No grave goods were found to be in association with Burial NN44.

Nojol Nah Burial 45

This burial, NN45, is that of a probable male, in the lose age-range of middle adult. Biological sex estimate was based on the robustisity of the skeletal remains, and a supraorbital margin score falling between 4 and 5. Age estimate was based on moderate dental wear, and that all teeth were in occlusion. There are four large caries present in the dental arcade. LEH was observed on the mandibular central incisor, canine and maxillary lateral incisor. Periodontal disease was also observed, as the maxillary gum line was pocketed with the small porosities which are indicative of this aliment. Burial NN45 was found within the construction fill under the floor of Room 1 of Structure 4D2. Head was to the east and there were no grave goods present in association with this interment.

Nojol Nah Burial 46

Burial NN46 is that of an older adult male. Age estimate was based on advanced osteophytic lipping on the thorasic and lumbar vertebrae and advanced dental wear. Sex was estimated based on a mental emenence score of 5 (hyper-male) and a greater sciatic notch score falling between 4 and 5. The individual suffered from pronounced tooth decay and tooth loss – the entire left mandable has been reabsorbed. Enemal hypoplasia can be observed on both maxillary canines, one lateral incisor, and one mandibular canine. The individual was interred with the head to the south, facing east, and was buried roughly a metre east of Burial NN45 in the last architectual phase of Str. 4D2.

Nojol Nah Burial 47

Burial NN47 is that of a young adult possible female. Age was based on only slight dental wear, though all teeth were in occlusion and there was complete epipyseal union. Sex was based on the extremely gracile bones. However, because that was the only indicator, it remains that the burial is deemed only “possible” female. The preservaiion of the skeletal remains was exceedingly poor, though three massive cavities were noted on two premolars and a canine. Although the horn of the hyoid is present, most of the other small bones are missing, which is indicitive of a secondary burial. Burial NN47 was found about a metre south of Burial NN46, within the construction fill of Structure 4D2.

Nojol Nah Burial 48

NOS Burial NN48 is that of an adult female between 30 and 40 years old at age-at-death. Though the mastoid process gave an ambiguous score of 3, sex was based on a sciatic notch score of 2, compiled with the very gracile nature of the bones. Age was based on tooth wear, which though they very corroded and in poor condition, were only slightly worn. There is also slight alveolar reabsorption surrounding the molars left in situ in the mandible. The individual had a modified cranium in the style of fronto-occiptial flattening (glabella to highest point = 154.36mm). An unsided maxillary incisor was found to be in type B4 reverse modification.

Nojol Nah Burial 49

Burial NN49 is that of a middle adult female. Age was based on moderate to advanced dental wear, and complete epiphyseal union. Sex was estimated based on a mastoid process score of 2, a supraorbital margin score which falls between a 1 and 2 and a mental eminence score of 2. There are five large cavities and two large drainage cloacae in the mandible. Along with these cloacae, the mandible also presents with pronounced alveolar reabsorption as well as periodontal disease. LEH is present on the maxillary central incisor, both lateral incisors and both canines. Skeletal modifications are present in the form of fronto-occipital flattening, and the maxillary central incisors are notched in B5 type, while the maxillary lateral incisors are in type C3. Though there are missing elements, the overall preservation of the skeletal remains are fair to good. This burial was discovered underneath the last floor of Room 1 of Structure 4C12 in a cluster of burials (NN49 through NN53). The remains were buried in a flexed position with the head to the south.

Nojol Nah Burial 50

Burial NN50 is that of a young adult of indeterminate biological sex. The only skeletal indicator which was present for estimating sex was the mental eminence, which scored the ambiguous score of three. Age was assessed through the very slight tooth wear, and complete epiphyseal union. There were five caries and LEH can be observed on both the maxillary central incisors, both mandibular central incisors, and a mandibular canine. There is also a healed fracture on the distal diaphysis of the left ulna, as well as another healed fracture on the left fifth MC5. Preservation was good, and many of the skeletal elements were present, though very fragmentary.

Nojol Nah Burial 51

Biological sex for Burial NN51 could not be determined. However, based on occlusion, dental wear, and rates of epiphyseal union it is estimated that the age of the individual falls within the immature range under 14 years old at age-at-death. Preservation of the remains is very good, however many skeletal elements are missing. The interment itself was a pit burial located under the most recent construction phase of Room 1, Structure 4C12, in a cluster of other burials (NN49 through NN53) (Brown 2012). The individual was buried in a flexed position, head to the north (Brown 2012).

Nojol Nah Burial 52

Burial NN52 is that of a young adult female. Age was based upon complete epiphyseal union, all dentition in occlusion, and yet only slight dental wear. Sex was based on a mastoid process score falling between 1 and 2, and a mental eminence score between 2 and 3. Caries were observed on both the maxillary and mandibular first molars. The individual of NN52 practiced fronto-occipital flattening. Preservation of these remains are fair, though many elements are missing. This burial was found underneath the latest construction phase of Room 1 Str. 4C12 in a burial cluster with NN49, NN50, NN51, and NN53).

Nojol Nah Burial 53

Burial NN53 is estimated to be a middle adult male. Age is based the articular surface being in phase four (aged between 35 and 39) and the symphyeal face of the pubis being falling between the stages of 4 and 5. Along with these all teeth were found to be in occlusion and there was complete epiphyseal union of all the surviving bones. Sex was based on a sciatic notch score of 5 (hyper-male), and a prearicular sulcus score or 4. Though preservation of this skeleton is very good, most of the skeletal elements are missing, and this is likely to be a secondary interment. This burial was found under the floor under the bench in Room 2 of 4C12.

Nojol Nah Burial 54

Burial NN54 is very well preserved. The individual was an adult female who died around the age of 30. Age is based on the articular surface averaging about a phase 3 (age 30-34) and very slight dental wear, and healthy dentition in general, with all teeth in occlusion. Sex estimate was based on a mastoid process score of 3, which is ambiguous, but the sciatic notch score was a 2, on the female end of the spectrum.. There is one cavity on the left mandibular first molar, and the left maxillary central incisor is notched, B4. The individual had a modified cranium in the style of fronto-occipital flattening, measuring 137.22mm at the widest point and 145.63mm from glabella to highest point. The burial was discovered at floor level under the bench in Room 2 Structure 4C12. The individual was buried in a flexed position, with the head to the north.

Nojol Nah Burial 55

The individual belonging to Burial NN55 is estimated to be a child/adolescent at age-at-death, likely between the ages of 9 and 11, of indeterminate biological sex due to its age-at-death. Age was based on the unfused nature of the epiphyses of the metacarpals and metatarsals (age of ossification typically occurs between the ages of 12 and 20 years old), incomplete ossification of the sacrum (age of fusion between 15-20), the distal epiphysis of the humerus is unfused (age 9-13) an unfused coracoid of the scapula (age of ossification between 12-20), the proximal end of the tibiae are not yet ossified (age 15-22). This burial was found in the construction fill of a bench in Room 2 Structure 4C12 and position could not be determined (Brown 2013).

Nojol Nah Burial 56

Burial NN56 was found within the construction fill of a bench in Room 2 of Structure 4C12. While biological sex for this individual could not be determined, age-at-death is estimated to be middle adult, and this is based on dental wear and complete ossification of the epiphyseal ends of long bone fragments. Five teeth exhibit caries, and moderate LEH can be seen on an unsided upper canine. The preservation of this burial was exceedingly poor, and though it is possible that the upper canine exhibiting LEH might also be culturally modified, it is too poorly preserved to determine which type of modification it would have been. Very little of this individual could be recovered, as such, mostly cranial fragments and pieces of long bone are represented, along with fragments of metatarsals.

Nojol Nah Burial 57A

Burial NN57A is that of a young adult male. Age was based on the fact that though there was complete epiphyseal union, there was only slight dental wear. Sex was based on a greater sciatic notch score of 5 (hyper-male) and supraorbital margin score and mental eminence score both of 4. The individual had multiple carious lesions on his dentition (maxillary central and lateral incisors), and has moderate LEH on both maxillary central incisors, both maxillary lateral incisors, both maxillary canines, both mandibular central incisors, and one unsided mandibular canine. The interment was scattered throughout the bench in Room 2, Structure 4C12 and were only partially articulated.

Nojol Nah Burial 57B

Unfortunately, not much can be said for Burial NN57B, the individual found with NN57A within the bench of Room 2, Structure 4C12. This individual was an adult at age-at-death, but biological sex could not be ascertained, and indeed much of the skeleton is not present. The individual had moderate LEH on one upper central incisor, and on one upper canine. The individual also had moderate osteophytic lipping on three vertebral bodies.

Nojol Nah Burial 58

Burial NN58 is that of a young adult female likely to have been between the ages of 21-25 at age-at-death. Sex was based on a sciatic notch score of 4 and also because the skeleton itself was very gracile. Stature estimate puts the individual at 1.58 to 1.64 m. Moderate LEH was observed on one unsided upper canine, and there is slight osteophytic lipping on one lumbar body. The overall preservation of the surviving skeletal material is fair to good. The burial itself was a semi-articulated pit burial which was an intrusion to the floor of Room 3, in Structure 4C12 and was the sole burial to be found within this room.

Nojol Nah Burial 59

Burial NN59 is that of a immature between the ages of 14 to 17 at age-at-death, and of indeterminate biological sex. Age is based on the unfused distal epiphysis of the ulna, which ossifies around the age of 17; the unfused radial head, which ossifies between the ages of 10 and 16; the glenoid fossa of the scapula is unfused; the proximal phalanges of the hand are unfused, as are several vertebrae. Finally, the medial epicondyle of the distal humerus is not yet fused, which occurs between the ages of 14 and 18. Preservation of the skeletal material is fair. Three caries were noted on an unsided M1 and a cavity was observed on the recovered M2. No cultural skeletal modifications were observed. Burial NN59 was found within the construction fill of the second phase floor in Room 2, Structure 4C12. No burial goods were recovered in association with Burial NN59.

Nojol Nah Burial 60

This burial was exceedingly fragmented, and poorly preserved. Only about 400 very small fragments. Because of this, while age was established as being an older adult, biological sex could not be determined. Age was based on the condition of the mandible, which was found to have had complete alveolar reabsorption. The burial was discovered in the construction fill laying just above the prehistoric A horizon, just west of the lower bench in Room 2, Structure 4C12. No burial goods were found in association with Burial NN60.

Nojol Nah Burial 61

In situ this burial appeared to be fairly preserved, particularly in regards to the cranium, however by the time of the analysis for this tudy the skeletal remains were highly fragmentary and poorly preserved, estimated at about 500 small fragments. Age-at-death was estimated to be middle adult, and sex as female. Age was based on the moderate dental wear, and slight osteophytic lipping on the vertebral bodies. Sex was based on the mastoid process score of 1, and inward flaring gonial angles. The skeleton itself appeared very gracile in nature. LEH was observed on a maxillary canine and lateral incisor, both central incisors, and both mandibular incisors. Skeletal modification was observed in the form of dental modification on both maxillary central incisors (type B4).

Nojol Nah Burial 62

The individual of Burial NN62 is estimated to have been an old adult of indeterminate biological sex. Age is based on complete epiphyseal union and moderate alveolar reabsorption around the mandibular canines extending to the molars. The preservation of the skeletal material is poor. The interment itself was likely a secondary burial, in a small crypt underneath the south wall on the east doorway of Structure 4C12 (Brown 2013). This is the sole burial that can be associated with the earliest phase of the structure (Brown 2013).

Nojol Nah Burial 63

Age other than being an adult, could not be determined for Burial NN63. Sex is estimated as probable male. Highly fragmented, N63 consisted mainly of cranial elements, long bone, and vertebral fragments. The dentition exhibited calculus and caries.

Nojol Nah Burial 64

Burial NN64 represents an adult male above the age of 45 years at age-at-death. Sex was based on a mandibular score of 4, while age was estimated based on alveolar reabsorption, osteophytic lipping on the vertebral body of L-3, and complete epiphyseal union. Cranial modification is present in the form of fronto-occipital flattening. The individual broke a left proximal phalange antemortem. While most of the bones of the upper body are represented in some capacity, much of the lower portion of the skeleton is missing, however it is unclear whether this is due to burial type, poor preservation, or excavator error.

Nojol Nah Burial 65

The individual of Burial NN-65 was highly fragmentary, the remains consisted largely of cranial fragments, and three phalanges of the hand and the left hamate was present, along with a number of small unidentifiable fragments. In addition, an unsided mandibular M1 was present, very worn, as well as the left mandibular M2 in which two carious lesions were recorded. Age and sex could not be determined. There is evidence of fronto-occipital flattening of the frontal bones. The individual was interred underneath the floor of Structure 4C11 (Brown 2013).

Nojol Nah Burial 66

Consisting mainly of ribs and vertebrae, as well as one navicular and two phalanges, Burial NN-66 is highly fragmentary. More so even than NN-65. Neither age nor sex could be determined other than general adult. An Ashote black ceramic vessel was found in association with the remains. The individual was interred within the fill of Structure 4C11 (Brown 2013).

Nojol Nah Burial 67

Nojol Nah Burial 67 is estimated to be an adult male between the ages of 30-40 at age at death. Much of the skeletal remains are present – particularly post-cranial--

and complete and the skeleton is in good condition. Sex was based on a mandibular score of 4 and age estimate was based on dental wear. What remains of the dentition is free of any caries, though there is moderate calculus build up on the mandibular central incisor. Slight osteophytic lipping is observed on the vertebral bodies of T-3 and T-4. The individual was interred underneath the floor of Room 1, Structure 4C11.

Nojol Nah NOS Burial 38

The individual buried in NN NOS 38 is that of an adult male. Age was estimated on both pubic symphseal surfaces being in stage three, moderate dental wear (advanced in some cases) and that all teeth had been in occlusion. Sex was based on a mastoid process score of 3 and mental eminence score of 4, as well as a particularly thick pubic ramus. There is possible mastoiditis on the left temporal just above the internal auditory canal. Caries were noted in all third molars. Dental modification was observed in numerous teeth (both maxillary central incisors in type E1, both maxillary lateral incisors also in E1, maxillary canines in type A2 and all of the mandibular incisors in type A2.) This burial was excavated at Casa Quemada, after a bulldozer had cut through the structure right into the burial. The remains were comingled with Burial 40 and because of the bulldozer disturbance burial position and type could not be ascertained.

Nojol Nah Burial NOS 40

Burial NN NOS 40 represents an adult male. Sex was based on a mastoid process score of 4 and highly robust skeletal remains. Age was based on the dental wear and complete ossification of the bones. Dental modification was observed in the maxillary central incisors (type E1). This burial was found under the floor of Casa Quemada adjacent to Burial 38. Both burials had been cut through with a bulldozer.

Nojol Nah NOS 11 Burial 41 TU 22 Lot 13

Age and sex of this individual is believed to be adult male. Age is based on tooth wear, the presence of the M3s and complete epiphyseal union. Sex is based on a mastoid process score of 5, a gonial angle score also of 5, and the highly robust nature of the skeletal remains as a whole. Stature is estimated to be between 167.13 and 169.47 cm. Skeletal modification was observed in the form of fronto-occipital flattening of the cranium and the presence of b4 type notching of one maxillary incisor. Overall perseveration of the skeletal remains of Burial NN NOS 41 is fair to good, though many elements are missing. The interment itself was located in a large crypt under the floor of Room 1 at Casa Quemada, in a supine position, facing the main community of Nojol Nah to the north.

Nojol Nah NOS 11 Burial 44

Biological sex for Burial NN NOS 44 could not be determined. However, age estimate, drawn from dental wear, was estimated as adult over the age of 45. The remains are highly fragmentary and preservation is poor to fair. The dentition suffers from numerous carious lesions (mandibular M2, M1, maxillary M2, M3) calculus (mandibular I1, maxillary I2) LEH was observed on the maxillary I2. Dental modification is also present (both maxillary I2s one in E1 and the other in C3, both maxillary canines in C3).

Nojol Nah NOS 11 Burial 47

Burial NN NOS 47 is that of an adult, probable male. Sex is based on a mastoid process score of 4, while age is based on complete ossification. The remains are highly fragmentary and most of the skeleton is missing. The clavicle exhibits signs of a possible healed fracture. Both maxillary central incisors are present, and are modified in type E1, one of which still has the hematite intact.

Nojol Nah Tulix Mul Burial 1

Age and sex could not be determined for Burial TM1 other than the individual was an adult when they died. Age is based on dentition and the presence of the third molars. Preservation of the skeletal material is exceedingly poor and the remains are highly fragmentary, with approximately 300 small fragments all together and about 15 percent of the cranium represented. The burial was a pit burial underneath the floor of Structure 4 and no burial goods were found to be in association with this burial (Hammond 2013).

Nojol Nah Tulix Mul Burial 2

Burial TM2 is estimated to be that of an adult male between the ages of 25 and 35 at age-at-death. Sex was based on a mental eminence score of 5 and the large robust nature of the long bones. Age was based on moderate dental wear and lack of any signs of osteophytic lipping. While preservation of the skeletal remains is quite good, there are still quite a few skeletal elements missing. Dental modification is present in the form of B4 notching on both of the maxillary central incisors, however not enough of the cranium remained to note whether there was any cranial modification practiced. The burial itself was located underneath the floor level of Structure 4, within the cobble ballast fill.

Nojol Nah Tulix Mul Burial 3

One human phalange and roughly 15 small fragments, also buried with a dog vertebrae.

Nojol Nah Tulix Mul Burial 4

Burial TM4 was located in Structure 4 at Tulix Mul in a small subfloor limestone crypt. Sex for the individual could not be determined, and age could only be estimated as an adult due to complete epiphyseal union. Preservation of the remains was poor, however, a healed fracture was observed on the distal portion of the proximal third phalanx of the hand. Dentition was too poorly preserved to analyse for caries and other dental pathologies. All together there are approximately skeletal fragments.

Nojol Nah Tulix Mul Burial 5

The individual of Burial TM5 is estimated to be that of an adult female between the ages of 35 and 45, placing her firmly in the Middle Adult range. Sex was based on a number of factors: a mastoid process score of 2, a mental eminence score also of 2, a supraorbital margin score of 3 (ambiguous) and a greater sciatic notch score of 2. Age was based on moderate dental wear, the fact that all teeth had been in occlusion with slight alveolar reabsorption, the antemortem loss of the mandibular left third molar, and complete epiphyseal ossification. In terms of cultural skeletal modification, the individual of Burial TM5 practiced cranial modification in the form of fronto-occipital flattening, and dental modification (both maxillary central incisors are in Type B4). Small carious lesions were observed on the maxillary left second premolar and two mandibular premolars. The individual was discovered fully articulated buried under the wall of the northern bench in Structure 4 and proceeds under the eastern floor (Hammond 2013). The burial was also found with copious burial goods comprising of an obsidian blade and fifty-three worked shell ornaments (Hammond 2013).

Nojol Nah Tulix Mul Burial 6

Burial TM6 represents that of an old adult female. Age is based on advanced dental wear combined with pronounced osteophytic lipping on the thoracic vertebral bodies. Sex is estimated based on a mental eminence score of 2, mastoid process score of 2 and a supraorbital margin score also of 2. A small cavity was observed on the mandibular right first premolar, while slight LEH was also seen on the mandibular left canine and several mandibular molars exhibit advanced calculus. Alveolar reabsobtion is also present in the mandible. Advanced cribra orbitalia can be observed in the eye orbits and along the brow ridge and mastoiditis can be seen surrounding the external auditory meatus on the left temporal. There is evidence of skeletal modification on the cranium as fronto-occipital flattening. The burial itself was located in a crypt underneath Burial TM5, and the skeleton was fully articulated in a flexed position (Hammond 2012). There were no burial goods found to be in association with this individual (Hammond 2012).

Nojol Nah Tulix Mul Burial 7

Burial 7 of Tulix Mul consists of only one medial phalanx of the hand. Based on rates of the epiphyseal union the individual was adult. Excavated within sub op A of Structure 3 at Tulix Mul (Hammond 2015; 2013).

Nojol Nah Tulix Mul Burial 8

Burial 8 of Tulix Mul consists of only about 20 tiny fragments. Excavated within Structure 4 at Tulix Mul (Hammond 2015; 2013).

Nojol Nah Tulix Mul Burial 10

Fill of a doorway, roughly 10 fragments, all cranial. Excavated from within Structure 4 at Tulix Mul (Hammond 2015; 2013).

Nojol Nah Tulix Mul Burial 12

Very fragmentary, only about 15 fragments all very small. The remains were interred under the lower floor of northern bench within Structure 4 at Tulix Mul (Hammond 2013).

Nojol Nah Tulix Mul Burial 14

Only about 20 tiny fragments of unidentified bone. The remains were found in the construction fill of the southernmost bench of Structure 4 at Tulix Mul (Hammond 2013).

Nojol Nah Tulix Mul Burial 18

Only a few long bone fragments were representative of this burial. Nothing diagnostic could be ascertained.

Nojol Nah Tulix Mul Burial 19

Unfortunately, not much can be assessed from Burial TM19. The remains were exceedingly fragmentary and most of the skeletal elements are missing. Roughly 250 very small unidentified fragments remain. Only three teeth are present (all maxillary) a central incisor, which has slight EH, canine, and first molar, all are too corroded to distinguish siding. The individual was buried under the floor of Structure 6 at Tulix Mul (Hammond 2013).

Nojol Nah Tulix Mul Burial 20

Burial TM20 is highly fragmentary, age has been left as unknown, other than general adult. Sex is estimated as probable male, based on a mastoid process score of 4. Dental wear is heavy on a number of teeth, and the mandibular right central incisor has a large carious lesion on the mesial side. Fronto-occipital flattening is evident based on the angle of the frontal bone fragments. All together this burial consists of about 300 very small fragments. The burial was under the floor of Structure 3 at Tulix Mul (Hammond 2013).

Nojol Nah Tulix Mul Burial 21

TM21 is the burial of an adult, probable female due to a mastoid process score of 2. Osteophytic lipping can be observed on T-8 through L-4. Partial L5 sacralisation occurred and there is an infection on the pelvis. Finally the right radial shaft is slightly bowed. Dentition is heavily worn, with slight LEH present on the left mandibular lateral incisor and right central incisor and the right maxillary lateral incisor, and there is a large carious lesion on the cervicoenemal line of the right maxillary first premolar, as well as on the mandibular left second premolar. Dental modification is present on the right maxillary central incisor, which is in reverse Type B2 style. This individual was excavated in Structure 8 of Tulix Mul (Hammond 2013).

Nojol Nah Tulix Mul Burial 22

Burial TM22 is that of an immature aged 15 +/- 3 years at age-at-death. Age was estimated based on an un-erupted right third molar as well as an unfused proximal epiphyses of the humerus. Biological sex however, could not be determined for this individual. A small carious lesion was noted on the buccal side of the right first molar as well as on the crown of the right maxillary second molar. The individual was interred within Structure 3 at Tulix Mul (Hammond 2013).

Nojol Nah Tulix Mul Burial 23

Burial TM23 is that of an immature aged three years at age-at-death and of indeterminate sex. Age is based on dental eruption patterns, as elements of both deciduous and permanent teeth are present within this assemblage. The skeletal remains consist primarily of cranial fragments though long bone fragments and vertebral elements are also present, along with a few phalanges. Cribra orbitalia was observed as severe and unhealed in the eye orbits while slight LEH can be seen on the right maxillary lateral incisor and a small carious lesion is present on the labial surface of the maxillary central incisor of the same side. The individual was interred within Structure 3 at Tulix Mul (Hammond 2013).

Nojol Nah Tulix Mul Burial 24

Burial TM24 is that of an adult male. Age was estimated based on complete epiphyseal union and the presence of osteophytic lipping on the bodies of T-9 and L-1. Sex is based on a mental eminence score falling between 4 and 5. Much of the dentition exhibit caries (the right maxillary first premolar shows small caries along the mesial cervix, both of the central incisors exhibit a carious lesion on the cervicoenemal lines). Also, there is slight LEH on the left maxillary lateral incisor. Dental modification can be seen on a number of teeth as well. The same left maxillary lateral incisor is modified in type F3, as is the left mandibular central incisor. The individual also had cranial modification done, in the form of fronto-occipital flattening.

Xnoha Burial 2A and 2B

Burial XO2a was found to be extremely comingled with XO2b and as such many of the elements could no be assigned as belonging definitely to one individual or the other. One of the burials, XO2a is well preserved, while the other XO2b has been heavily affected by the taphonomic process with the result being that it is very poorly preserved. Both individuals represented in these burials were young adults, based on all dentition being in occlusion, and suffering from minimal tooth wear. Complete epiphyseal union was also noted for both individuals. Sex could not be determined for either individual. One suffered from moderate cribra orbitalia in the eye orbit. A healed fracture on the ulna was also noted, but whether or not the fracture belonged to the same individual as the cribra could not be determined.

Xnoha Burial 3

Burial XO3 is exceedingly poorly preserved. Indeed, along with this most of the skeletal elements are missing and therefore biological sex could not be determined. Age is limited to the broad category of adult not further specified. Many of the elements presents are vertebral, the upper limbs are also represented along with a fragment of pelvis, a few phalanges and one fragment of the maxilla. The burial itself dates to the second construction phase of the structure. The remains were found in a flexed position, with a ceramic bowl to the south.

Xnoha Burial 4

Not much remains of Burial XO4. Sex is estimated to be possible female, based on a mastoid score of 2 but that is the sole indicator of biological sex. Age is estimated to be older adult, based on osteophytic lipping of the vertebral bodies on the thoracic and lumbar vertebrae. The overall condition of the skeletal remains is good. The individual was buried at the end of a bench on the floor. The individual was buried in a tightly flexed position, with no associated grave goods. The construction fill in which the remains were buried however, date to the Late Terminal Classic.

Xnoha Burial 5

Burial XO5 is represented only by roughly ten cranial pieces, primarily frontal and parietal, all in very poor condition. All that can be determined is that the individual was an adult at age at death. Biological sex could not be ascertained.

Xnoha Burial 13-01

The individual represented in Burial XO13-01 is that of an adult of indeterminate biological sex. Though poorly preserved, dental wear is minimal (though there is heavy calculus on the labial side of the left mandibular central incisor) possibly indicative of a young adult. The skeleton is very poorly preserved. The burial itself was discovered deep under the construction fill of the Preclassic plaza platform of group 78, placing the remains firmly within the Preclassic period.

Xnoha Burial 13-02

Unfortunately very little remains of Burial XO13-02. Both age and sex can only be noted as indeterminate, however the individual was likely an adult at age-at-death simply based on ossification. There are only about 70 very small fragments. The preservation of the remains was exceedingly poor, the matrix in which the burial was discovered was limestone and chert cobble, as well as silty soil which was moist, thus the remains were not in good condition and no diagnostic features, for the biological profile or in terms of health indicators, could be determined. Any signs of dentition was also absent from the burial. The burial was discovered under the floor of Room 3 in Structure 68 at Xnoha. Room 3 is the smallest room in the structure, measuring only 1 X 2.5 meters. The burial was located at the north of the room, towards the courtyard, partially under the east wall. However, due to the poor preservation of the burial it is difficult to determine if this was deliberate, or if the burial shifted due to taphonomy. A single small slate matate was found in association with this burial.

Xnoha Burial 13-03

Burial XO13-03 is highly fragmentary, with only one partial shaft of lone bone present (about 40 bone fragments). Teeth are too corroded to analyse. Despite this, dentitions suggests the individual was an immature between the ages of three to five years old at age-at-death.

Xnoha Burial 13-04

Burial XO6 is estimated to be that of an adult male. Age is based on all dentition being in occlusion and overall size of the skeletal remains. Sex is based only on a single indicator, but it is a sciatic notch score of 5, therefore it is extremely likely that this individual was male. The remains are poorly preserved and highly fragmentary. The remains represent a possible secondary burial, due to a lack of smaller bones, as well as that only long bones, pelvic bones, cranium and dentition were recovered. The dentition was very worn and very poorly preserved. However, possible LEH was observed on the left mandibular central incisor and the right mandibular canine. The individual was buried in the cobble construction fill of the southwest corner of Room 4 in Structure 68 at Xnoha. The position of the individual was indeterminate, as the remains were greatly displaced by intruding roots of a large Ramon tree. No associated burial goods were found in association with this burial.

Xnoha Burial 14-01

Burial XO14-01 is very poorly preserved. The individual belonging to Burial XO14-01 was an adult aged between 30 and 50 years at age-at-death. This is estimated based on dental wear, all teeth in occlusion, and complete epiphyseal union. Biological sex is estimated to be possible male, based on a mental eminence score of 4, however this score was the only diagnostic indicator available. Thought for the most part the teeth appeared to be healthy apart from wear, a few molars did have caries along the cervicoenemal line on the buccal side. The individual practiced dental modification, in that both upper central incisors are modified in Type B4 modification. The individual was interred within the fill of Structure 16 at Xnoha.

Xnoha Burial 14-02

Only a few fragments represent Burial XO14-02. As such neither age nor sex could be determined. The one tooth, an incisor, is a permanent tooth, but nothing else is indicative of age or any other type of diagnostic indicator.

Xnoha Burial 14-03

Burial XO14-03 is that of a probable male, between the ages of 30 and 40 years old at age-at-death. Age was based on dental wear combined with a general lack of osteophytic lipping. While highly fragmented, much of the skeleton was represented, including many long bone fragments, metacarpals and metatarsals, ribs and vertebrae and a very well preserved sternum. However, only roughly 5% of the pelvis is represented and only about 10% of the cranium is present. The remains appear healthy, apart from a healed fracture on the third distal phalanx of the hand. The dentition fits the wear of an individual between the ages of 33-45 and also appears quite healthy, aside from the maxillary left first molar, which has a cavity. While not enough of the cranium remains to determine if the individual practiced cranial modification, dental modification is present in the form of Type C3 on all four maxillary incisors.

Xnoha Burial 14-04

Only three small fragments represent this burial, including one parietal fragment. As such, age and sex could not be estimated. The remains were found in the bench of Structure 16 at Xnoha.

Xnoha Burial 14-05

Burial XO14-05 was found to be very comingled with XO14-07, however 14-05 was very displaced while 14-07 was almost entirely articulated. Both were buried under the floor adjacent to a subfloor wall in Structure 79 at Xnoha. Though some elements are missing the remaining skeletal material was found to be in excellent condition, with even the styloid processes intact. The individual represented in Burial XO14-05 is estimated to be a young adult female, between the ages of 17 and 21 at age-at-death. Sex is based on a supraorbital margin score between 1 and 2, mastoid process score of 2, and a supraorbital ridge score between 1 and 2. The remains themselves were also very gracile in nature. Age was based on the maxillary third molar, which was found in situ, not fully erupted. This individual suffered from early stages of periodontal disease, based on the small porosities dotting the gum line, and moderate LEH is seen on the on the left maxillary first premolar and right maxillary canine. The individual also had a healed fracture in the distal phalanx of the foot (unsided), and a well healed once broken humerus**.** Affected by abnormal bone growth, which is likely endocrine in nature, the individual also suffered from elongated styloid processes, on both the left and right in what is perhaps a rare case of Eagle's syndrome.

Xnoha Burial 14-06 2014

Unfortunately, not much can be ascertained from Burial XO14-06. Aside from about 30% of the cranium being represented, only a few fragments of bone were present. As such neither age nor biological sex could be determined. The remains were found in the small corridor between Structures 16 and 16A at Xnoha.

Xnoha Burial 14-07

Burial XO14-07 was found very comingled with Burial XO14-05, under the floor of Structure 79, adjacent to a well built subfloor wall. While XO14-05 was very affected by bioturbation and position could not be determined, the skeletal remains of XO14-07 were well articulated, buried in a tightly flexed position. Because the remains were so comingled, the photos for XO14-07 do not illustrate all of the bones present, just those which are certain to be belonging to XO14-07 and not those which are ambiguous with 14-05 and the same is true for XO14-05. While this burial was less affected by bioturbation than XO14-05, it was more affected by taphonomy and root damage is extensive. The remains are estimated to be an adult male, between the ages of 30 and 50 at age-at-death. Estimate of sex was based on the robust bones, a mastoid process score of 4 and a mental eminence score of 5 (hyper male). Age was based on the wear of dentition. Porotic hyperostosis is present on the left portion of frontal. Heavy calculus can be observed on both mandibular central incisors, and the maxillary first molar has a cavity. There is alveolar reabsorption where the left third molar would otherwise be present.

Xnoha Burial 14-08

Burial XO14-08 is that of an adult, probable male, about 45 to 55 years of age at age-at-death. Age is based on the wear of dentition, while biological sex estimate is based on a sciatic notch score of 4 and the very robust nature of the remains themselves. A cavity is present of the cevicoenamel line of the left maxillary first molar, and calculus is present on most of the molars. The individual had dental modification preformed, as the maxillary right central incisor is modified in Type B3, the left lateral incisor is in Type B7, and the left canine is in Type A1. Modification was not observed in any of the mandibular dentition. Though many skeletal elements were missing, the preservation of the remains was fair to good. The individual was buried subfloor in Structure 79 at Xnoha.

Xnoha 14-09 13-02

Other than the rather ambiguous age range of "adult, not further specified," neither age nor biological sex could be determined for Burial XO14-09. The remains were highly fragmentary and most of the skeletal elements were missing, aside from a few fragments of the distal femur, and fibula and a fragment of patella as well as an unsided distal phalanx. Of the dentition, only one tooth was excavated, a mandibular right second molar, which was very much affected by the taphonomic process. The remains were found without any associated grave goods, underneath the floor of Structure 79 at Xnoha.

Xnoha 14-10

Burial XO14-10 is estimated to be that of an old adult, of indeterminate biological sex. While most of the skeletal elements are missing or highly fragmented, age was based on the severe wear of the dentition (both mandibular first molars, three first premolars, two second premolars and two lateral incisors) which are worn almost completely smooth. Altogether there are about 150 very small fragments of bone which represent the individual interred in Burial XO14-10.

Xnoha Burial 14-11

The skeletal remains interred within Burial XO14-11 were highly fragmented and most of the skeletal elements were missing. However, while biological sex could not be determined, age was estimated to be that of an old adult, based on the heavy attrition of the dentition. An unsided maxillary central incisor also exhibits heavy calculus. All together about 300 small fragments represent this burial. The burial itself was found within Bench B of Structure 16 at Xnoha in the summer of 2014.

Xnoha Burial 14-12

Burial XO14-12 is represented only by thirty fragments of long bone fragments. As such, neither age –apart from general adult-- nor biological sex could be ascertained.

Xnoha Burial 14-13

Burial XO14-13 is that of a male, between the ages of 30 and 40 years old at age-at-death. Sex estimate was based on a sciatic notch score between a 4 and 5 and the very clearly defined muscle attachments on the tibia. Age was based on dentition, with an absence of any osteoarthritis. The femoral head measures 39.03mm. The dentition exhibits heavy calculus on the maxillary left central and lateral incisors, the right lateral incisor, and the mandibular right central incisor. Linear enamel hypoplasia is observed on the maxillary right central and lateral incisors. There are possible healed fractures in the phalanges (see figure) The individual also practiced dental modification on the right maxillary central and lateral incisors, and the left maxillary central and lateral incisors.

Xnoha Burial 14-14

Burial XO14-14 was found under the plaza floor, of group 78. The burial was in a large crypt and was buried head to the north in a flexed position. The burial also included a number of grave goods. A jadeite cylinder bead, two “kin” beads which fit together and create the “kin” sign, and a incensario in the shape of a turkey, which dates the burial to the Preclassic. The individual within Burial XO14-14 was an adult of indeterminate biological sex. Age was based on dental wear and complete epiphyseal union. The remains were in poor condition however, and only long bone fragments, 15% of the cranium, a few teeth (the maxillary third molar, unsided; right canine and central incisor, also unsided, and a mandibular central incisor, also unsided) and three partial phalanges of the hand. As such, not much of the skeleton could be analyzed, however the only remaining molar has a large carious lesion, extending from the cervicoenemal line downwards into the root.

Xnoha Burial 14-15 13-02

The age and sex of the individual from Burial XO14-15 could not be determined, other than the individual was an adult at age-at-death. This estimate is based on complete epiphyseal union. Along with fragments of long bone, carpals, a few phalanges and ribs and two fragments of cranium, there are about 100 unidentified fragments. Of the dentition only the maxillary right central incisor remains. A healed fracture in a distal phalanx of the foot was noted. Other than that phalanx though, nothing remains which could act as a diagnostic. The burial itself was found in the subfloor cobble ballast of Structure 79 at Xnoha, and no grave goods were found in association with the burial.

Xnoha Burial 14-16A

Burial XO14-16A was found very comingled with Burial XO14-16B. The remains represent that of an adult of indeterminate biological sex. The bones themselves are highly fragmentary and not very well preserved. The remaining dentition is worn with caries on the right lower premolars and right second molar.

Xnoha Burial 14-16B

Burial XO14-16B represents that of an immature of indeterminate sex. The remains were found very comingled with Burial XO14-16A. Many of the skeletal elements are missing, and only about 75 small bone fragments represent this burial, along with one tooth, a possible mandibular lateral incisor.

Xnoha Burial 14-17

Burial XO14-17 is that of an adult of indeterminate biological sex. Age was based on complete epiphyseal union. Of the few teeth that remain, the right first premolar and left second premolar both have caries.

Xnoha Burial 14-18

Burial XO14-18 represents that of an immature around the age of 8 years old at age-at-death, of indeterminate biological sex. Age was based on dental eruption and rates of epiphyseal union. While there are many skeletal elements missing, the remains themselves are in good condition. The individual was interred in the bench of Structure 16 at Xnoha.

Xnoha Burial 14-19

Neither age nor sex could be ascertained for Burial XO14-19 as all the burial consists of is a single vertebral lamina.

Xnoha Burial 14-20

Unfortunately not much could be determined in regards to Burial XO14-20. Only twenty small bone fragments were recovered during excavations, and as such neither age nor sex could be estimated.

Xnoha Burial 15-01A

This individual was part of a possibly bundled burial on the steps of Structure 10 at Xnoha (Pastrana and Trowbridge 2016). The individual was comingled with two other adults (XO 15-01B and XO 15-01C) and is estimated to be male.

Xnoha Burial 15-01B

This individual was part of a possibly bundled burial on the steps of Structure 10 at Xnoha (Pastrana and Trowbridge 2016). The individuals was estimated to be an adult male and was comingled with XO 15-01A and XO 15-01C.

Xnoha Burial 15-01C

This individual was part of a possibly bundled burial on the steps of Structure 10 at Xnoha (Pastrana and Trowbridge 2016). The individuals was estimated to be an adult of indeterminate sex and was comingled with XO 15-01A and XO 15-01C.

Xnoha Burial 15-02

This individual is thought to be a young adult male, likely in his early twenties. The mandible is hyper-male, and the individual has strong muscle attachments. However, at the same time the bones are very gracile, indicative of an individual being in their early twenties. The bones all appear to be healthy and are in conditions ranging from fair to good, though all are extremely delicate. Caries are found on the cervical enamel line of the maxillary left M2 and mandibular left M1 and P1. The individual also had a maxillary supernumerary tooth. Although there is no dental modification present, this individual does exhibit cranial modification in the form of fronto-occipital flattening. The individual was buried within a bench in Structure 15-03 (Moodie 2016). The burial itself, Burial XO15-02, was marked by a cut in the bench surface and no grave goods were recovered in association with this burial (Moodie 2016). The individual was buried in a loosely flexed position with the head to the south facing north. The individual is missing all elements below the lumbar, i.e. no pelvis or lower limbs were recovered despite thorough excavation. For a number of reasons this could be indicative of the burial being re-entered and the lower limbs removed. Firstly, the circular cut mark in the surface of the bench could be the re-entry point, as burials within floors are often marked with cut marks bench burials rarely are. Secondly, the upper limbs and torso were all intact and in anatomical position, save for the only recovered lumbar vertebra, which was flipped. This vertebra was also the last remaining bone before the absence of the lower half of the skeleton.

APPENDIX B

COMPLETE BURIAL LIST

Burial Number	Biological Sex	Age	Time Period
BC-AW-1	Indeterminate	Adult	Late Classic
BC-AW-2	Indeterminate	Adult	Late Classic
BC-AW-3	Female	Old Adult	Early Classic
BC-AW-4	Indeterminate	Subadult 15 +/- 3	Classic
BC-AW-5	Not applicable	Subadult 2-3	Classic
BC-AW-6	Male	Subadult under 18	Classic
BC-AW-7	Indeterminate	Adult	Classic
BC-AW-8	Male	Adult 30-40	Classic
BC-AW-9	Indeterminate	Adult	Classic
BC-AW-10	Male	Old Adult	Classic
BC-AW-11	Indeterminate	Adult	Classic
BC-AW-12	Indeterminate	Adult	Classic
BC-AW10E60	Indeterminate	Middle Adult	Classic
BC-AW10F36	Indeterminate	Adult	Classic
BC-BV-1	Indeterminate	Adult	Terminal Classic
BC-BV-2	Male	Adult	Terminal Classic
BC-BV-3	Indeterminate	Adult	Terminal Classic
BC-BV-4	Indeterminate	Adult	Terminal Classic

BC-BV-5	Indeterminate	Old Adult	Terminal Classic
BC-1	Indeterminate	Adult	Early Classic
BC-2	Male	Middle Adult	Preclassic
BC-3	Female	Adult	Early Classic
BC-4	Indeterminate	Adult	Preclassic
BC-5	Male	Adult 30-50	Early Classic
BC-6A	Not applicable	Subadult 8-11	Preclassic
B BC-7	Indeterminate	Middle Adult 25-35	Preclassic
BC-8	Female	Middle Adult	Early Classic
BC-9	Male	Middle Adult	Early Classic
BC-10A	Not applicable	Subadult	Early Classic
BC-10B	Male	Adult	Early Classic
BC-11	Female	Adult	Preclassic
BC-12	Indeterminate	Adult	Early Classic
BC-16	Indeterminate	Adult	Preclassic
BC-17	Not applicable	Subadult	Preclassic
BC-20	Indeterminate	Adult	Preclassic
BC-27	Not applicable	Subadult 3-5	Preclassic
BC-31	Indeterminate	Adult	Classic
BC-32	Male	Adult	Preclassic
BC-33A	Indeterminate	Adult	Classic
BC-33B	Not applicable	Subadult	Classic
BC-34	Male	Middle Adult 25-35	Preclassic
BC-35	Male	Middle Adult 30-40	Preclassic
BC-36	Indeterminate	Adult	Preclassic
BC-37	Male	Adult	Late Classic
BC-38	Indeterminate	Middle Adult	Late Classic
BC-KT-39	Indeterminate	Adult	Late Classic
BC-KT-40	Indeterminate	Adult	Early Classic
BC-KT-41	Indeterminate	Adult	Late Classic
BC-KT-42	Indeterminate	Adult	Late Classic
BC-43	Indeterminate	Adult	Classic
BC-KT-44	Indeterminate	Middle Adult	Early Classic
BC-KT-45	Indeterminate	Adult	Early Classic
BC-47A	Indeterminate	Adult	Early Classic
BC-47B	not applicable	Subadult	Early Classic
BC-48	Indeterminate	Adult	Early Classic
BC-50	Indeterminate	Adult	Classic
BC-51	Indeterminate	Adult	Late Classic
BC-52	Indeterminate	Adult	Classic
BC-53	Indeterminate	Adult	Classic
BC-54	Indeterminate	Adult	Classic

BC-55	Indeterminate	Adult	Classic
BC-56	Female	Adult	Classic
BC-2/85	Not applicable	Subadult 18 months	Preclassic
BC-CC-26	Indeterminate	Adult	Classic
BC-KT-J-14A	Not applicable	Subadult age 4	Classic
BC-KT-J-14B	Male	Subadult 15-17	Classic
BC-KT-J-14C	Male	Old Adult	Classic
BC-KT-J-14D	Male	Middle Adult 25-45	Classic
BC-KT-J-14E	Male	Middle Adult 25-35	Classic
BC-KT-J-14	Male	Adult	Classic
BC-AM-65	Male	Adult	Late Classic
BC-SH-1	Indeterminate	Adult	Classic
BC-SH-2	Indeterminate	Middle Adult 25-30	Classic
BC-SH-3	Indeterminate	Adult	Classic
BC-KT-G	Male	Adult	Classic
BC-CC-47	Female	Young Adult	Early Classic
BC-CC-29	Indeterminate	Adult	Classic
BC-CC-49	Indeterminate	Adult	Classic
BC-CC-15	Indeterminate	Adult	Classic
BC-CC-18	Indeterminate	Adult	Classic
BC-CC-25	Indeterminate	Adult	Classic
BC-CC-26	Indeterminate	Adult	Classic
BC-CC-24	Indeterminate	Young Adult	Classic
BC-CC-28	Indeterminate	Adult	Classic
BC-CC-30	Indeterminate	Adult	Classic
BC-CC-H	Indeterminate	Adult	Classic
BC-CC-G	Indeterminate	Adult	Classic
BC-CC-N	Indeterminate	Adult	Classic
BC-CC-K	Indeterminate	Adult	Classic
BC-CC-M	Indeterminate	Adult	Classic
BC-CC-J	Indeterminate	Adult	Classic
BC-CC-L	Indeterminate	Adult	Classic
BC-CC-O	Not applicable	Subadult	Classic
BC-CC-Q	Indeterminate	Adult	Classic
BC-CC-53	Indeterminate	Adult	Terminal Classic
BC-CC-6B	Female	Adult	Preclassic
NN-1	Not applicable	Subadult 11-13	Early Classic
NN-2	Not applicable	Subadult 2-3	Early Classic
NN-3A	Possible male	Subadult 12-15	Early Classic
NN-3B	Not applicable	Subadult	Early Classic
NN-3C	Male	Adult 40-55	Early Classic
NN-4	Female	Old Adult ~60	Early Classic

NN-5A	Not applicable	Subadult 6	Early Classic
NN-5B	Indeterminate	Old Adult	Early Classic
NN-6	Female	Young Adult 17-24	Early Classic
NN-7	Male	Middle Adult 35-40	Late Classic
NN-8	Not applicable	Subadult ~6.5	Early Classic
NN-9	Female	Old Adult 50-60	Early Classic
NN-10A	Not applicable	Subadult 10-13	Late Classic
NN-10B	Indeterminate	Adult	Late Classic
NN-11	Not applicable	Subadult 12-14	Late Classic
NN-12A	Male	Middle Adult 35+	Late Classic
NN-12B	Not applicable	Subadult 12-14	Late Classic
NN-13	Female	Adult	Late Classic
NN-14	Indeterminate	Adult	Late Classic
NN-15A	Not applicable	Subadult 2-4	Late Classic
NN-15B	Female	Adult 20-30	Late Classic
NN-16	Female	Adult 40	Late Classic
NN-17	Male	Adult 45+	Late Classic
NN-18	Male	Adult 30-40	Late Classic
NN-19	Not applicable	Subadult 3-5	Late Classic
NN-20	Female	Adult 40	Late Classic
NN-21A	Female	Adult 45+	Late Classic
NN-21B	Female	Adult 50+	Late Classic
NN-22	Female	Adult 35+	Late Classic
NN-23	Indeterminate	Young Adult	Late Classic
NN-24	Male	Adult	Late Classic
NN-25	Female	Old Adult	Early Classic
NN-26	Male	Adult 30-40	Early Classic
NN-27	Not applicable	Subadult 12-15	Late Classic
NN-28	Female	Old Adult	Early Classic
NN-29	Male	Old Adult	Early Classic
NN-30	Male	Old Adult	Early Classic
NN-31	Female	Young Adult 15-24	Early Classic
NN-32	Indeterminate	Young Adult	Early Classic
NN-33	Male	Adult	Early Classic
NN-34	Female	Old Adult	Early Classic
NN-35	Female	Adult	Early Classic
NN-36	Female	Old Adult	Early Classic
NN-37	Female	Adult 45-55	Early Classic
NN-44	Indeterminate	Young Adult	Late Classic
NN-45	Male	Middle Adult	Late Classic
NN-46	Male	Old Adult	Late Classic
NN-47	Female	Young Adult	Late Classic

NN-49	Female	Middle Adult	Early Classic
NN-50	Indeterminate	Young Adult	Early Classic
NN-51	Not applicable	Subadult ~14	Early Classic
NN-52	Female	Young Adult	Early Classic
NN-53	Male	Middle Adult 35-39	Early Classic
NN-54	Female	Middle Adult ~30	Early Classic
NN-55	Not applicable	Subadult 9-11	Early Classic
NN-56	Indeterminate	Middle Adult	Early Classic
NN-57A	Male	Young Adult	Early Classic
NN-57B	Indeterminate	Adult	Early Classic
NN-58	Female	Young Adult 21-25	Early Classic
NN-59	Not applicable	subadult 14-17	Early Classic
NN-60	Indeterminate	Old Adult	Early Classic
NN-61	Female	Middle Adult	Early Classic
NN-62	Indeterminate	Old Adult	Early Classic
NN-63	Male	Adult	Early Classic
NN-64	Male	Old Adult 45+	Early Classic
NN-65	Indeterminate	Adult	Early Classic
NN-66	Indeterminate	Adult	Early Classic
NN-67	Male	Middle Adult	Early Classic
NN-NOS-38	Male	Middle Adult	Late Classic
NN-NOS-39	Female	Middle Adult 30-40	Classic
NN-NOS-40	Male	Middle Adult	Late Classic
NN-NOS-41	Male	Adult	Late Classic
NN-NOS-44	Indeterminate	Old Adult 45+	Classic
NN-NOS-47	Male	Adult	Classic
NN-TM-1	Indeterminate	Adult	Early Classic
NN-TM-2	Male	Adult 25-35	Early Classic
NN-TM-3	Indeterminate	Adult	Early Classic
NN-TM-4	Indeterminate	Adult	Early Classic
NN-TM-5	Female	Adult 35-45	Classic
NN-TM-6	Female	Old Adult	Late Classic
NN-TM-7	Indeterminate	Adult	Early Classic
NN-TM-8	Indeterminate	Adult	Early Classic
NN-TM-10	Indeterminate	Adult	Classic
NN-TM-12	Indeterminate	Adult	Early Classic
NN-TM-14	Indeterminate	Adult	Early Classic
NN-TM-18	Indeterminate	Adult	Classic
NN-TM-19	Indeterminate	Adult	Early Classic
NN-TM-20	Male	Adult	Early Classic
NN-TM-21	Female	Adult	Early Classic
NN-TM-22	Not applicable	Subadult 15 +/- 3	Early Classic

NN-TM-23	Not applicable	Subadult 3 years	Early Classic
NN-TM-24	Male	Adult	Early Classic
XO-2A	Indeterminate	Young Adult	Late Classic
XO-2B	Indeterminate	Young Adult	Late Classic
XO-3	Indeterminate	Adult	Late Classic
XO-4	Female	Old Adult	Early Classic
XO-5	Indeterminate	Adult	Late Classic
XO-13-01	Male	Young Adult	Preclassic
XO-13-02	Male	Adult	Terminal Classic
XO-13-03	Not applicable	Subadult, 3-5	Preclassic
XO-13-04	Male	Middle Adult	Terminal Classic
XO-14-01	Male	Middle Adult 30-50	Preclassic
XO-14-02	Indeterminate	Adult	Preclassic
XO-14-03	Male	Middle Adult 30-45	Late Classic
XO-14-04	Indeterminate	Adult	Preclassic
XO-14-05	Female	Young Adult 17-21	Late Classic
XO-14-06	Indeterminate	Adult	Early Classic
XO-14-07	Male	Middle Adult 30-50	Late Classic
XO-14-08	Male	Old Adult 45-55	Late Classic
XO-14-09	Indeterminate	Adult	Late Classic
XO-14-10	Indeterminate	Old Adult	Preclassic
XO-14-11	Male	Old Adult	Preclassic
XO-14-12	Male	Adult	Preclassic
XO-14-13	Male	Middle Adult 30-40	Late Classic
XO-14-14	Male	Adult	Preclassic
XO-14-15	Male	Adult	Late Classic
XO-14-16A	Male	Adult	Preclassic
XO-14-16B	Not applicable	Subadult	Preclassic
XO-14-17	Indeterminate	Adult	Early Classic
XO-14-18	Not applicable	Subadult 8	Preclassic
XO-14-19	Indeterminate	Adult	Late Classic
XO-14-20	Female	Adult	Early Classic
XO-15-01a	Male	Middle Adult	Early Classic
XO-15-01b	Male	Middle Adult	Early Classic
XO-15-01c	Indeterminate	Middle adult	Early Classic
XO-15-02	Male	Young Adult	Early Classic